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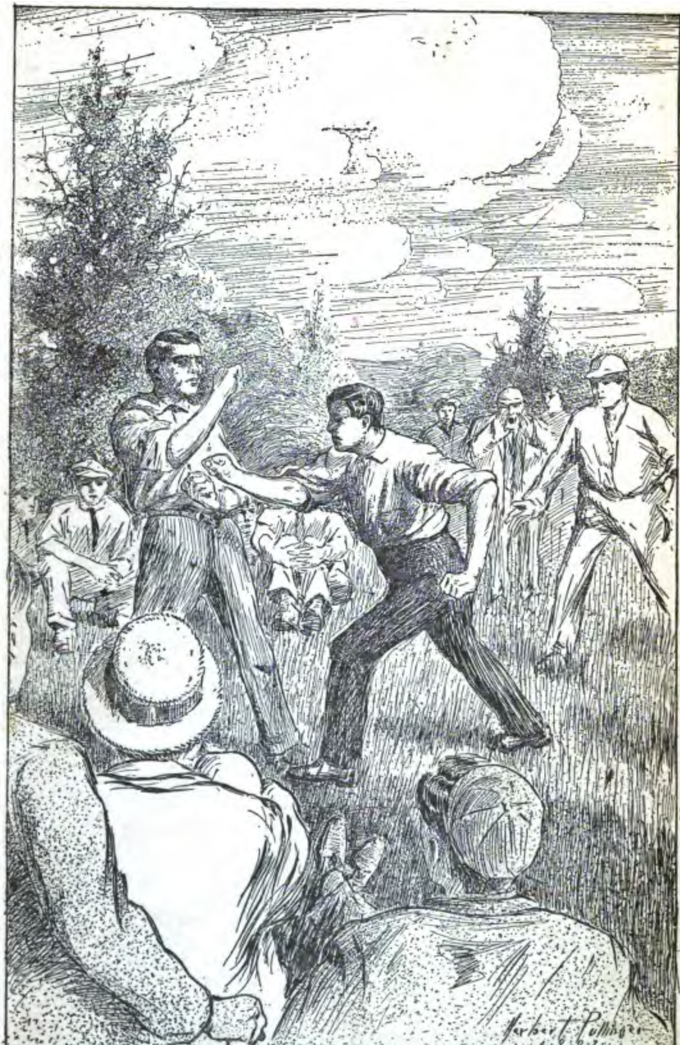

" 'GIVE IT TO HIM HOT, BERT' "

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The Boy Geologist

AT SCHOOL AND IN CAMP

by

EDWIN J. HOUSTON, Ph. D.

Author of "The Young Prospector, or The Lost Gold Mine."

With illustrations

by HERBERT PULLINGER

NAS

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PREFACE

IN "The Boy Geologist" an effort has been made to trace the school life of a number of healthy boys at a time when they are apt to take an especial interest in the things that afterwards form their life work. The scene is laid in a large boarding school in the suburbs of Philadelphia.

The story treats of the wonderful doings of the "boy geologist," a bright lad with an inherited taste for geology, and his particular chum, a lad with a similar taste for chemistry. These lads, together with a small coterie of their particular friends, enjoy a number of interesting experiences that are apt to occur in almost any large school, and are, perhaps, for that very reason, especially attractive to other boys.

PREFACE

The recent disastrous eruption of Mount Vesuvius, and the terrible earthquakes at San Francisco and Valparaiso, make the present an especially suitable time for referring to the more important phenomena of volcanoes and earthquakes. For this reason, in "The Boy Geologist" the author has given special attention to this class of geological phenomena.

It is the author's hope that while reading the story, and endeavoring to understand some of the difficulties of the "boy geologist" and his companions, his readers will unconsciously gain no little information on this branch of natural science.

E. J. H.

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THE BOY GEOLOGIST

AT SCHOOL AND IN CAMP

CHAPTER I

MALLORY ACADEMY FOR BOYS

IT was noon at the Mallory Academy for boys. The morning session was just over, and two boys of the first form, the highest form in the Academy, were sitting in a shady nook of the playground, eating lunch and talking.

The boys were Albert A. Bridges and Frederick Brown. They were nearly of the same age, about sixteen, and were properly regarded as the brainiest boys in the Academy. Both were hard students, and held the highest places in their classes, sometimes one and sometimes the other leading. This rivalry, however, was of a generous character, and, so far from setting the boys against each other, only drew them more

closely together. Indeed, they were such intimate friends that they were known among the older boys as Damon and Pythias, while the younger boys, though they did so under their breaths, called them the Siamese Twins.

Both boys had a marked taste for physical science. Bert was especially interested in geology, in which he was so well versed that he was often called by his classmates the "boy geologist." He had not only made himself familiar with the greater part of the text-book used in the Academy class in geology, but had also read many of the books on this subject in the Academy and other libraries. Moreover, whenever he could, he had compared the rock formations and fossils, about which he had read, with actual specimens in the geological cabinet of the Academy.

Bert inherited his fondness for geology from his grandfather and father, both geologists of recognized ability, the latter being now engaged in professional work in the great diamond fields

of Kimberly, about six hundred miles southeast of Cape Town in South Africa.

Fred possessed a marked fondness for chemistry, and was as far in advance of the other boys in the school in this branch as his friend was in geology. Like Bert, Fred was a great reader, but unlike him, did not so closely limit his reading to a single branch, but covered a wide range of subjects. Fred had a wonderfully retentive memory, often being able to remember the exact words of what he once read. Indeed, his memory was so remarkable that it was well known in the Academy. His schoolmates would often lay skillful traps to catch him, but Fred generally came out of such tests with flying colors.

The Mallory Academy took its name from its head master, Dr. Mallory, a scholarly man, greatly beloved by all the boys. The Academy was situated in one of the suburbs of Philadelphia, and was one of the best schools of its kind for boys in Pennsylvania. It was a board-

ing school, but took a limited number of day scholars.

One day, while talking in the shady nook before referred to, Fred, observing that his chum had a worried look, remarked:

"Why do you look so glum, Bert?"

"That miserable lesson in geology we have to recite this afternoon. I would rather be thrashed any day than recite it."

Knowing the fondness of his chum for this study, Fred replied:

"You surprise me, Bert. I can't understand why you should hate to study this lesson. I'll bet you've already been all through our text-book. Ain't I right?"

"Yes; I have gone through the book by my-self, as well as I could, and although there are many things in it I cannot understand, yet I know most of it fairly well."

"Then, why would you rather be thrashed than study the lesson we have for this after-noon?"

"I didn't say I would rather be thrashed than *study* the lesson, I said I would rather be thrashed than *recite* it. There is a big difference between studying a lesson and reciting it. At least," he added, "reciting it the way we have to do for Smith."

"What do you mean?"

"When I study a lesson I try to understand it thoroughly, not only from our text-book, but also from any other books I can get. But when I have to prepare a lesson to recite to such a teacher as Mr. Smith, it is not ideas that I must remember, but words; for, as you know, he insists that we recite our lessons pretty nearly word for word. Now, this is such a loss of time, and is so senseless, that I am honest when I say I would rather be thrashed than prepare a lesson for him, especially in a subject that I like as well as I do geology."

"Now I understand what you mean, and I agree with you, Bert. It is a miserable way of reciting, just repeating the words of the book.

I dislike it myself very much, but, as you know, I have a good memory, and have no trouble in giving Smith the words of the lesson exactly as they are written."

"A miserable way? I should say so. You could teach a poll parrot geology by this method, or still better, could read the lesson out loud to a phonograph cylinder, and roll if off afterwards when information was required."

"I say, Bert, do you think Smith understands geology himself?"

"I strongly suspect he does not. He is never willing to explain things to me, and when I speak to him about matters I have read elsewhere, he seems to know nothing about them."

"Then I guess it's pretty clear that he is not well up on the subject."

These two boy friends were not mere bookworms. On the contrary, they were thorough boys, fairly bubbling over with life and fun. Fortunately, there was an excellent department of physical culture in the Academy, so that they

had ample opportunities for developing their bodies as well as their minds. Both Bert and Fred could hold their own against almost any of the boys in the Academy, either in the gymnasium on the parallel bars, the horizontal bar, the flying rings, or at basketball; or, on the athletic grounds, in jumping, running, football, baseball, and the other sports of which healthy boys are so fond.

The school authorities did not permit the boys to become lopsided in their development. Each boy was obliged to take up a number of different studies. Dr. Mallory earnestly advised the boys not to attempt to become specialists in any one study before they had laid a good broad foundation in all other studies. Sometimes, when boys like Bert and Fred let their fondness for special studies result in the neglect of their other studies, the greatest punishment the Doctor could inflict was forbidding them from studying, for a week or so, the branches they cared most for.

The Mr. Smith about whom the boys were talking was the teacher of the physical sciences. As the boys suspected, and, indeed, as is generally the case with teachers who insist on *verbatim* recitations, he attempted in this way to conceal his ignorance. He carried this so far as to make his work at the Academy valueless, for his methods placed a premium on imperfectly prepared work. Many of the duller boys found it easier to commit their lessons to memory than to try to understand them. The study of the physical sciences, therefore, had a setback at the Academy. Bert and Fred would never have made the progress they had in geology and chemistry had they been long under his instruction. Fortunately, Mr. Smith had only been in charge of the department of physical sciences since the beginning of the school year.

As soon as the two boys finished their lunch, they took a stroll across the playground, when two of their companions, Patrick O'Connor, an

Irish lad and a great practical joker, and Heinrich Schmidt, a stolid German boy who had only recently come over from Germany, approached them.

"I say, boys," cried Bert, "do you know your lesson in geology?"

"Yes," said the German, "I have him here," pointing to his forehead.

"And Oi have it here," said the Irish boy, pointing to the end of his tongue.

"There are three-quarters of an hour before the bell rings," said Bert. "Let's have a race to the baseball diamond, the first two boys there to choose up sides for a game. I see a crowd of fellows going there now."

"All right," said the other boys. "Patsy, you count and we are off on the word 'three.'"

Bert won the race, Fred coming in only a few feet behind. There was no trouble in starting a game of baseball. It was agreed that, should the bell ring for the afternoon session before the nine innings were completed, the

score should be counted from the number of full innings played.

It was an exciting game. The sides were well matched, Bert and Fred being among the best players in the Academy. When the bell rang for the afternoon session, six full innings had been played, the score standing 4 to 4, so the game was declared a tie.

As the boys were going toward the Academy, Fred whispered to Bert:

"There will be fun in the geology class this afternoon. Patsy O'Connor has prepared a wonderful fake geological specimen, that he claims was sent him by an uncle in South America. He has palmed it off on Schmidt as a valuable specimen of gold ore. You know Schmidt is making a collection of minerals. He, therefore, is greatly tickled with the specimen, and is going to show it to Mr. Smith to-day during the recitation."

"I hope Patsy won't get poor Heinrich in trouble," said Bert.

"Don't worry about that. Patsy is more likely to get into trouble himself."

"Yes; and if he does, he is also able to get out of it; for Patsy knows how to take care of himself."

The dreaded lesson was assigned for the first period of the afternoon session, so that on reaching the school building they went directly to Mr. Smith's classroom.

"I will give you five minutes to look over the lesson," said Mr. Smith. "Remember, I shall insist on your giving me the exact words of the book in their proper order. Well, what is it, Schmidt?" he asked, petulantly, as Heinrich raised his hand.

"Herr Teacher," said Heinrich, "I wish to show you a beautiful specimen of gold ore that I from South America have obtained."

Heinrich had been in America for somewhat less than a year, so that his English was broken. When he first came to the Academy, the boys laughed at the curious manner in which he ex-

pressed himself, and were even yet greatly amused, at times, at the odd language he used. When excited his language became more and more like that of his mother country.

"Don't bother me now," said Mr. Smith. "Keep the specimen till the recitation is over. Our most important business now is the recitation."

"I beg you vill me excuse, Herr Teacher," said Heinrich. "As our lesson is on rocks, I thought dat to see dis beautiful specimen you vould be much pleased."

"All right, Schmidt. Wait until the proper time; then I will examine your specimen of ore."

At the end of the allotted five minutes, the class was called to recite. The recitation was a wretched juggling of words, no attempt whatever being made to find out if the boys understood the meaning of the words they were reciting. Under such circumstances, it was impossible to excite any real interest in the lesson. Not only were the words of the text insisted on, but

the boys were required to give these words in the exact order in which they were used in the book.

The lesson was on the origin, formation and condition of rocks, a subject that, if properly handled, can be made intensely interesting. Under the method of teaching adopted, however, it dragged heavily along.

Some idea of the extent to which Mr. Smith's foolish method of recitation was carried may be had from a question given to Bert. This question was as follows:

"Into what three classes may rocks be divided according to their origin?"

Bert replied:

"Rocks may be divided according to their origin into three classes: aqueous, igneous and metamorphic."

"Wrong," said Mr. Smith. "Next."

The next boy, who gave the classes as metamorphic, igneous and aqueous, was also passed. Fred was then called on. Knowing both the exact words and their order, he answered:

"Rocks may be divided according to their origin into three distinct classes: igneous, aqueous and metamorphic."

"Correct," said Mr. Smith.

"Mr. Smith," said Bert politely, "did I not give the same answer?"

"No," said Mr. Smith. "The book does not give it as you stated it, Bridges. The book says, 'igneous, aqueous and metamorphic,' and you said, 'aqueous, igneous and metamorphic.' You can't be too careful about the words you use in describing natural phenomena."

"But, Mr. Smith," said Bert, "may I ask a question?"

"Certainly. What is it?"

"What difference, sir, is there between my answer and the answer Brown gave. You didn't ask me the names of the rocks in the probable order of their formation. If you had, then igneous rocks snould have been named first, the aqueous rocks next, and metamorphic last."

"I refuse to discuss the matter with you,

Bridges. I wish my questions answered both in the words of the book and in their exact order. You don't suppose you are able to improve on the book, do you? Well, O'Connor," he continued, as Patsy raised his hand, "what do you want? What have you to do with this?"

"Arragh, Mr. Smith," said Patsy, who, when excited, was, like Schmidt, apt to break out in his native brogue, "by the token of what ye have said, Oi think Bridges desarves one-third a full mark, for bedad he gave ye one of the koinds of rocks in the order of the book."

"What do you mean, O'Connor?" asked Mr. Smith, who began to fear he had made a mistake.

"Sure," said Patsy, "Oi mane that Bridges gave the metamorphic rocks in both the words and order of the book."

"I did not think of the matter in that light, O'Connor. I will give Bridges three, or the value of one-third of a perfect recitation."

Then, wishing to dismiss the matter, he said:

"We still have some ten minutes left. Schmidt, I will now look at the specimen of gold ore you wished to show me."

"Yes, Herr Teacher, I will show you my beautiful specimen of gold ore dat I from South America haf just received." With this, he handed Mr. Smith a piece of stone containing a number of small shining particles that had the color of gold.

Now Mr. Smith knew even less about mineralogy than about geology. Instead of keeping on the safe side by giving a vague opinion as to the mineral substance, he took a small magnifying lens out of his pocket, and placing the specimen to his eye, looked at it through the glass, and said:

"This is a very beautiful specimen, Schmidt. It is unquestionably gold ore, and I should say, from its appearance, a very rich ore. I am not surprised, however, since you tell me that it comes from South America, as I know that South America contains many exceedingly rich

gold mines. I can distinctly see the particles of gold with my pocket lens. This is so beautiful a specimen, that if you do not object, Schmidt, I would like to pass it around the class and let all the boys carefully examine it with the lens."

The praise of his specimen greatly pleased Heinrich.

"It would much pleasure gif me for my classmates to look at dis beautiful specimen that I have," said Heinrich proudly.

The boys examined the specimen, passing it rapidly from one to another. At last O'Connor took it, and looking at it for a moment only, turned to Heinrich and said:

"Where did ye get this, Heinrich?"

"You vant to know vhere I got dot?" said Heinrich, as he turned his face, beaming with satisfaction, toward Patsy. "It vas you dat vas so kind as to gif him to me. You tell me you got him from South America."

"Thin it's a mistake Oi've made, and Oi most

humbly ax your pardon,'' said Patsy, winking one eye so that his classmates could see it, but without permitting the teacher to detect it. ''This is something that Oi made myself intoirely the other day in the laboratory in order to find out by experiment whether shining particles of brass, when mixed through Portland cement, could kape their bright color. As Oi see, the experiment was successful, for the pieces of brass look so much loike gold that they have intoirely decaved an expert loike our teacher. Heinrich, I must have given you this in mistake for this beautiful specimen I have in my pocket.'' With that, Patsy took out of his vest pocket a specimen of real gold ore from South America, adding:

''It's Patsy O'Connor that axes your pardon, Heinrich, for the onpleasant position in which he has placed ye.''

As soon as Patsy finished his explanation of the origin of the specimen, a roar of laughter broke out in the class, all discipline being mo-

mentarily swept away. Mr. Smith, both angry and mortified, began to explain how readily one could be mistaken by the similarity in the appearance of brass filings and particles of gold. Patsy, however, would not let up on him. Assuming a look of honest inquiry he asked:

"And do Oi understand ye to say, Mr. Smith, that the bits of gold look loike the bits of brass filings?"

"Yes, Patsy," said the now thoroughly discomfited teacher. "Look for yourself," handing him the specimen of true gold ore and the piece of stone containing the brass filings, together with his pocket lens. "You will see that they are exactly alike."

"Oi see, sir, that they are exactly alike in color," said Patsy, "but bedad, Oi do not see that the shape is at all the same. Indade, they are intoirely different in shape."

"You don't know how to observe natural objects, O'Connor. It can only be acquired by practice. Bridges, take my pocket lens, care-

fully examine the specimen, and tell O'Connor how mistaken he is."

Bert took the glass and made a careful examination of the specimen as requested, but said nothing.

"Well, Bridges, why don't you tell me what you think?"

"I would rather you would excuse me, sir," said Bert modestly.

"What do you mean, sir?" demanded Mr. Smith roughly. "I insist on your telling me just what you see through the glass."

"Since you insist on my telling, sir, I see that while in color the particles of brass closely resemble particles of gold, in shape they are entirely different. In this specimen of real ore, the particles of gold evidently consist of placer gold, cemented together by an oxide of iron. Now, placer gold always has rounded edges, due to the wear of the particles as they have been carried from place to place. In Schmidt's specimen, the shining particles,

consisting as they do of brass filings, have the sharp and rugged edges that were left by the teeth of the file. I agree with O'Connor that the two specimens do not at all resemble each other as regards the shape of the shining particles."

Bert's explanation of the difference in the appearance between the particles of the real and the spurious gold ore was so clear that the class saw that another mistake had been made by their teacher. There was, therefore, another roar of laughter from the boys. On this second breach of discipline, Mr. Smith lost his temper completely.

"O'Connor," he said, "you have set a trap for me, and you, Schmidt, have aided him in it. Bridges, your remarks are exceedingly impertinent. O'Connor, Schmidt, and Bridges will come with me to Dr. Mallory. I shall insist that he punish you for your conduct. The class is dismissed. As the disorder has been general, you will take for your next lesson in geology,

in addition to what I have already assigned, two extra pages, and will, moreover, bring me a neat pen-and-ink copy of the entire lesson."

This announcement was received with loud murmurs of discontent. Many of the boys, instead of going to their next classroom, followed Mr. Smith and the other boys to Dr. Mallory's room. Seeing this, Mr. Smith turned to them and asked angrily:

"Why are you following me? Brown," he added, singling out Fred, "I did not tell you to come to Dr. Mallory's room, but if you insist on it, come along with the others."

Mr. Smith, who was greatly excited, placed himself in a very unfavorable light before the head master. When the evidence of the boys was heard as to the manner in which the recitations had been conducted, and the ridiculous statements made by Mr. Smith concerning the fake specimen had been repeated, the Doctor, who for some time had been far from satisfied with the work in this department, concluded

that it was time to dismiss the teacher. Of course, he did not say as much to the boys. O'Connor was severely reprimanded for the practical joke he had played. Heinrich was completely vindicated as regards any guilty knowledge of the matter, while Bert and Fred were not at all blamed.

That day, before the school was dismissed, a rumor was whispered that the Doctor had summarily dismissed Mr. Smith, it being stated that Mr. Smith had told one of the school servants that he was leaving the Academy for ever.

CHAPTER II

THE NEW TEACHER OF PHYSICAL SCIENCE

ONE week had passed since the events recorded in the preceding chapter. The rumor concerning the dismissal of Mr. Smith proved true; the old teacher had gone and a Mr. Johnson, who had been appointed and introduced to the whole school, had assigned a lesson to the class in geology.

It was the noon hour. Bert and Fred were again sitting in their favorite nook in the playground, eating lunch and talking. As was natural, the conversation soon got on the new teacher, who, it was clear, had impressed all the boys very favorably.

The lesson assigned the class was the same lesson on rocks referred to in the preceding

chapter, and the boys were wondering how it would be taught. The conversation then touched on O'Connor's fake specimen.

"Bert, wasn't that a capital joke Patsy played on Smith?"

"It was, indeed, and I am glad it was successful, for it has given us a new teacher. It would be a shame for a teacher to lose his position by reason of such a joke, but Smith behaved so badly that I think it served him right. Fred, I suspect you had a hand in the preparation of that wonderful specimen. It was made up in a manner that suggested greater knowledge of chemistry than Patsy possesses. Am I not right?"

"You're right. Patsy came to me and asked how he could prepare a specimen, containing brass filings, that would look like gold ore. Of course, I showed him. I didn't say anything to you about the matter, thinking it might get you in a scrape. We tried a number of experiments before getting a specimen that suited.

At last we got up a very good specimen, as I think you will acknowledge."

"Yes, it was great. It fooled Smith, all right. When he said, 'I can distinctly see the particles of gold with my pocket lens,' I could hardly keep from laughing."

When the class in geology was assembled for recitation, the new teacher said:

"Boys, I hope you have thoroughly prepared this lesson. I think we will recite it with our books open."

The statement that the books might be kept open during the recitation was a great surprise. It certainly looked to the boys like a great snap. Recite the lesson with the books wide open! What could the new man be thinking about? Why, the answers could be taken directly from the printed page. An excited buzz of whispered conversation went around the room. Here, indeed, was a revolution as regards methods of recitation. While the more thoughtful of the boys inferred that they might expect good and

thorough instruction, most of them, including O'Connor, were nearly dumfounded.

"But, teacher," said Patsy, excitedly, "suppose we rade the answers out of the book? Will that be all right?"

"Certainly," said Mr. Johnson. "That is why I wish you to leave the books open. I see, O'Connor, that you do not understand how a lesson can be heard in this manner. Am I right?"

"Right ye are, sir," cried Patsy.

"Well then, suppose I begin with you, O'Connor. Can you tell me into what three classes rocks may be divided according to their origin?"

"I can," said Patsy, deliberately reading the answer word for word from the open book.

"Yes, O'Connor," said Mr. Johnson, "that is what the book says. Now tell me, please, what it means. Mere words by themselves are of no value in the physical science. It is *ideas* I am after."

Patsy endeavored to explain the meaning, but

succeeded only very imperfectly, as did several others of the boys who followed him.

"Will some boy tell me in his own words just what the words O'Connor has recited mean?"

Bert immediately raised his hand.

"All right, Bridges," said Mr. Johnson, "tell me."

"It means, sir, as I understand it, that all rocks consist either of materials originally melted by heat, which have afterwards hardened on cooling, or they consist of hardened rocks that have become broken into smaller pieces by various agencies, and then spread out in more or less regular layers or strata while in a suspended condition in water; and that, between these two general classes, there exists a third class called metamorphic rocks, formed of aqueous rocks that have been subjected, while in a moist condition, to great heat and pressure, so as to have lost all traces of stratification."

"Excellent. Do you happen to know whether

there is not another class into which rocks may be divided according to their origin?"

"Yes, sir. There is a fourth class known as Æolian rocks, or rocks that consist of finely divided materials that have been regularly arranged in layers by the action of the wind."

"Very good, Bridges. I am glad to see that you not only understand the lesson as it is contained in our text-book, but have also read outside the book. This is a capital plan when one wishes to master a subject. I trust that you are not the only one who prepares his lessons in this way. Now, I would like," he said, turning to the class, "to see if any boy can give me a good definition of igneous rocks in words other than those contained in the book. First, let me have it in the words of the book," calling on one of the boys to read; and the following reply was given:

"Igneous rocks are those that were originally thrown out from the interior in a molten condition, and afterwards cooled."

"Now, Brown, let's have a definition of igneous rocks in some other words."

"Rocks that a long time ago were fused and have since cooled," answered Brown.

"Correct," said Mr. Johnson.

In the same manner, definitions of aqueous and metamorphic rocks were read from the book by different boys, and afterwards explained in their own language.

It is needless to say that this method of recitation at once gained the full attention of the class. It placed a premium on ideas completely disconnected from mere words. When a boy was asked to read the answer from the book, he tried his best to understand what he read, since he knew that an explanation would be called for.

"Now," said Mr. Johnson, "how many boys think they thoroughly understand the different kinds of rocks, and the manner in which they were formed."

At once nearly all the boys raised their hands, indicating that they believed they did.

"O'Connor, let me see whether you understand the matter now."

"That Oi will, sir, and bedad, Oi won't look at the words in the book at all. A long time ago, the earth was melted intoirely. When it cooled on the outside, the hardened stuff made what are called igneous rocks. And then, as the outside got colder, it grew smaller and began to crowd the inside. 'Stop that, I tell ye,' said the inside to the outside; 'ye are crowdin' me.' 'Indade, Oi'll not stop at all, at all,' said the outside. 'Thin Oi'll come out and make you stop, for Oi am the bigger man!' 'Come out if ye dare!' said the outside. And then the inside came out through cracks in the crust, and the water on the outside ran in and there was a great scrap, and the ocean was made dirty with the broken bits of the inside and the outside. It was these bits that settled in layers and made the aqueous rocks. In some places, sir, these same aqueous rocks became so hot and were so squeezed together intoirely, that they clane for-

got they had ever been aqueous rocks, and these were called metamorphic rocks.''

Patsy's odd recitation raised a loud laugh in the class. The teacher, however, did not appear to object, but called it an excellent recitation.

''That is very good, O'Connor. Do you see now that it is possible to recite a lesson intelligently with the book open?''

''Indade Oi do, and Patsy O'Connor is to-day a happy boy for having a teacher who can make a hard subject loike rocks so soft and aisy.''

''Oh, come, O'Connor,'' said Mr. Johnson, good-naturedly, ''none of your blarney.''

''But indade I mane it,'' said Patsy earnestly. ''It's no blarney at all, at all, sor.''

''Well, boys, now close your books and I will see whether you can recite intelligently on this subject.''

He then began a rapid cross-fire of questions, most of which required only very short answers, but none of which could be answered unless the subject-matter had been thoroughly mastered.

"Now give me your close attention, and I will tell you about the men who discovered the manner in which these different kinds of rocks were formed. It, perhaps, seldom occurs, even to thoughtful boys, how much hard work has been required on the part of a few able men to discover general principles that we can now thoroughly master in a few hours of close study. This is especially the case with the information about the three classes of rocks we have been studying. Would you like to hear something about the pioneer work in this department of geology?"

"Yes, sir," came unanimously from all the boys.

"It took the best part of the life work of three very distinguished men to discover that practically all the rocks on the earth's crust were formed either by the agency of water, by that of heat, or by their combined agency. These men were Abraham Göttlieb Werner, James Hutton, and Leopold von Buch. Werner traced

the origin of aqueous rocks, Hutton of igneous rocks, and von Buch of metamorphic rocks. But we will consider separately the work of each of these men.

"Werner lived in a part of Germany where extensive mining operations had led to the sinking of deep shafts in the earth. He was Professor of Geology and Mineralogy in the college at Freiberg, and spent much of his time in studying the appearance presented by those parts of the earth's crust that he could examine when lowered into the mine shafts. Although fairly many books had been written on geology at this time, yet none were very advanced, so that Werner was obliged to get much of the material for his lectures from the actual study in the shafts. He tried in this manner to discover the way in which rocks had been formed. It happened, in the particular part of Germany where he lived, that the rocks that had been arranged in layers by sediment deposited in water, or were aqueous rocks. Unfortunately, Werner,

who had never traveled widely, made the mistake of supposing that rocks were formed in all parts of the world as he found them in Germany. He founded a school of geology known as the Aqueous School. His students accepted his views and joined him in writing scientific papers trying to prove the aqueous origin of all rocks.

"You must not suppose that Werner had no difficulty in building up his theory of the aqueous origin of rocks. On the contrary, when he persuaded the workmen to lower him down the shafts, so that he could closely examine the rocks forming their sides, and saw how the mineral materials were arranged in more or less regular layers or strata, it puzzled him no little to understand how this arrangement was brought about. After much thought and study, he was at last able to see that if the minerals forming the rocks had once been suspended in water, while in a divided state, they would necessarily arrange themselves in more or less regular layers or strata. In this way, he

finally formed his ideas concerning their aqueous origin.

"About this time, a teacher of geology named James Hutton was doing in the neighborhood of Edinburgh, Scotland, just what Werner was doing in Germany. Now, curiously enough, in this part of the world, the materials forming the crust of the earth looked as if they had flowed through the crust while in a molten condition, and had afterwards hardened. Hutton, who had never traveled far outside of Scotland, fell into the same error that Werner had made, in supposing that as the rocks were formed in Scotland, so they were necessarily formed in all other parts of the world. Hutton formed a school of geology known as the Igneous School.

"Both Hutton and Werner, and especially their students, published numerous scientific papers on the formation of rocks. In this manner, Werner learned that there was a man in Scotland who thought that all rocks were formed by the agency of heat, while Hutton

learned that a certain man in Germany taugth that all rocks were of aqueous origin. Instead of going to the places where these rocks existed and studying them for themselves, Werner and Hutton both made the mistake of endeavoring to prove the correctness of their views by long and so-called scientific papers.

"One day there came into Werner's class-room, in the college, a new student, a young man named Leopold von Buch, an earnest man, who gave his entire time to the study of geology. He enthusiastically accepted the teachings of Werner, and joined the great army of ink-slingers in preparing scientific papers intended to show that all rocks were of sedimentary origin. Von Buch, however, soon learned all that Werner knew. He then became troubled about certain things he read in the writings of Hutton, and others of the Igneous School, which he could not understand, and decided to go and study for himself the peculiar appearances of rocks in other parts of the world.

"In those days, traveling was very different from what it is now. Even if von Buch had been a rich man, which he was not, traveling would then have been a slow matter. As it was, he was obliged to travel on foot, carrying with him the scant change of clothing he possessed.

"The results were as might have been expected. Von Buch was a bright man, and a close observer. The further he got from his home, the more puzzling were many of the rock formations he observed. Some of these he was totally unable to explain on the supposition of their aqueous origin. At last he came across rocks that left no reasonable doubt of their having once been in a fused condition. He then made the great discovery that Hutton was right in saying that rocks could be formed by the agency of great heat, but at the same time was wrong in claiming that *all* rocks had such an origin, of course discovering at the same time that Werner was equally mistaken in some of his conclusions.

"But von Buch did much more than this for the science of geology. He not only clearly proved the aqueous and igneous origin of rocks, but also showed that there existed an intermediate class, consisting of rocks that were originally deposited as sediment in regular layers, but had afterwards lost nearly all traces of their stratification by the agency of heat acting on them while in a moist condition. He proposed the name *metamorphic* rocks for this class.

"As you can see, boys, the lesson you have just learned in so short a time concerning the three kinds of rocks required practically the life time of three very bright and hard working men to discover."

As the class was dismissed, Fred turned to Bert and said:

"Well, what do you think of him?"

"Oh, he is just splendid. Now we can learn the physical sciences as they ought to be learned."

"And what do you think of him, Patsy?"

"What do Oi think of him? Oi think he is great, intoirely! No more stupid recitations for me. It is ashamed of myself, Oi am, that whin Oi gave him the words of the book I was no more able to tell him what they meant than if I had been reading Grake to him. It's not me that will be acting in so stupid a manner another time."

"I say, Patsy, don't try any tricks on Mr. Johnson with your make-up gold ore specimen."

"Indade, Ói would niver drame of the loike," said Patsy. "It's not for such a man as Misther Johnson that Oi would attempt to get up a fake specimen. Troth, Oi am too much interested in what he teaches us to waste my time with jokes."

CHAPTER III

BERT'S BIRTHDAY PARTY

ON the dismissal of the Academy that afternoon, Bert said to Fred:

"Don't forget, Fred, that you promised to take supper with me to-night. Mother expects you; I told her you had promised to come."

"Don't worry, my boy. I enjoy taking supper at your house too much to forget the engagement. Your mother makes it so pleasant for boys that I am always glad to get an invitation. And besides," he said, seeing that Bert was smiling, "I am also glad to take supper with my chum. Just wait until I run home and freshen up a bit, and I will come to your house. But why can't you go home with me and wait

until I get ready? I'll not keep you longer than half an hour, or just time enough to dress."

Fred's father was a very rich man. His house was in one of the western suburbs of Philadelphia. It was a large single house, or one that stood separate from those around it. In this respect it differed from the houses in the greater part of the main city, where sometimes as many as twenty or twenty-five were erected in a single row. As they entered the house, Fred's little brother, Percy, came running to meet him.

"Hello, little kid," said Fred, opening his arms, into which Percy sprang. "Come, give brother a good hug," which the youngster affectionately did.

"Don't call me a little kid," said Percy. "I am a big boy; I am three years old," opening his eyes wide as if astounded at his vast age.

"Well, then," said Fred laughing, "I won't call you a little kid, I will call you a kidlet."

"That's better," said Percy. "That's a bigger word than kid."

"Percy," said Fred, "you haven't spoken to Mr. Bert."

"Good afternoon, Percy," said Bert. "Haven't you a hug for me?"

"Yes," said Percy, springing into his arms and heartily giving him one.

In less than the promised half hour, Fred had made the change, and was ready to go to Bert's house. They met Fred's mother down stairs.

"Good afternoon, Bert," said Mrs. Brown. "Fred tells me he is going to spend the evening with you."

"Yes, mother, and perhaps I will stay over night. We have a difficult lesson in mathematics for to-morrow, and I think if Bert and I get up early and study it together, we can help each other understand it."

"I don't generally like your sleeping away from home, Fred, but I don't object to your doing so with Bert, provided, of course, it is

convenient for Mrs. Bridges," was his mother's reply.

Bert's home was not far from Fred's. It was a much smaller house than that in which Fred lived; for, as we have already said, Mr. Bridges was engaged in professional work in the diamond mines of South Africa, so that the family at home consisted of Bert and his mother.

As they were sitting at the supper table, Mrs. Bridges said:

"Albert, you told me that your class was to have its first recitation in geology to-day with your new teacher. How do you like him?"

"O mother," said Bert, "he is just splendid! What do you think? We recited the lesson with our books open, and it was a great recitation. Now I shall have an opportunity of learning geology as I know father would like me to learn it."

"And what do you think of the new teacher, Frederick?" asked Mrs. Bridges.

"Why, he's a jolly good teacher. I never

had a lesson taught so clearly as the one we had to-day."

"I am very glad, Albert, to hear this of your new teacher; for, as you know, both your father and I are anxious that you should be thoroughly educated in geology," said his mother.

"Yes," said Bert, "and I am anxious to do so myself, for when I finish my education, I intend to be a geologist, as father is."

"What do you expect to be when you have completed your education, Frederick?" inquired Mrs. Bridges.

"I hope to be a chemist."

"Albert," said Mrs. Bridges, toward the end of the supper, "next Wednesday will be your birthday. Would you not like to invite the new teacher to take supper with us on that evening, together with three or four of your classmates?"

"Yes, mother, that would be splendid," said Bert, "I would like to do it very much. I should especially like to have you meet Mr. Johnson."

"How many boys are there in your class in geology?" asked Mrs. Bridges.

"There are only twelve, mother."

"Then ask three boys besides Fred to supper, and invite all the rest to call after supper, say at 7.45 P. M. We will try to give them a pleasant evening."

"Thank you, mother. This is Thursday, I will ask the boys to-morrow at school, as soon as I find out whether Mr. Johnson can come."

Mr. Johnson accepted the invitation. He was glad to have an opportunity of seeing more of Bert, to whom he had been especially attracted, and was, moreover, pleased to meet socially the boys of the class in geology.

All the boys promised to be present, there being the double attraction of having a jolly evening at Bert's, and of seeing more of the new teacher.

The invitations for supper included, besides Mr. Johnson, Fred, Heinrich, Patsy, and Jack Adamson.

Bert's mother so thoroughly understood boys that by the time the party assembled at the supper table they were quite at their ease. The conversation tended naturally toward school matters. During a part of this conversation, Patsy remarked to Mr. Johnson:

"It's right glad Oi am that you don't care much about memory. It's ideas that you want, Oi'm thinking."

"Yas," said Heinrich, "dot iss a splendid way. Vhen you vants to find out somedings about a lesson, you don't haf to gif yourself so much trouble about de vords, dot you forget to remember what dey mean."

"What do you think about that, Albert?" asked Mr. Johnson.

"Ideas are all right. If trying to remember the words leaves no room for ideas, I think it well to let the words go. Still," he said, "one cannot get along without words, and it's often very valuable to be able to remember them also. I don't think, sir, that you would say

that it is not a good thing to cultivate the memory."

"You are right, Albert," said Mr. Johnson. "I have been afraid the boys might think I attached but little importance to the cultivation of the memory. On the contrary, it is not only useful, but indeed necessary, to cultivate this faculty. Have you not noticed, boys, that some of your classmates can remember things much better than others?"

"Yes, sir," instantly came from all the boys. "There is no boy in the school who can remember things as well as Fred."

"Is that so," said Mr. Johnson smiling. "If you would like me to do so, Albert, when all the boys are here this evening, I think I can entertain them with some games and tests of memory."

"I should very much like to have you do so," said Bert.

The remainder of the boys who were to call after supper were so prompt that by eight

o'clock they had not only all arrived, but were feeling fairly at home, and were beginning to have a good time. Later in the evening, Bert passed around word regarding Mr. Johnson's promise to entertain them with tests of memory, and memory games. Under this prompting the boys soon gathered around their teacher requesting him to begin.

"All right, boys," he replied. "I will be glad to do so. You must not suppose from the way I conducted your first recitation in geology that I care but little for the memory of mere words. On the contrary, the cultivation of the memory of what we hear is of great importance. While some people naturally have better memories than others, yet it is possible for any one to greatly improve his memory, no matter how poor it may seem to be. I remember a long time ago reading a funny story of a man who went about the country describing a memory system, by means of which he claimed he could teach any one to readily remember anything he had once

heard. His system could not have been a good one, for there happened to be present in one of his audiences a great wag, who scribbled off a lot of nonsense on a slip of paper, and asked the lecturer if he thought he would be able to repeat it if it was read to him but a single time.

"'Oh, yes,' said the lecturer confidently. 'Read it to me but once, and I will repeat it word for word.'

"The writing on the slip of paper was read slowly and distinctly to the man, but it was of such an extraordinary character that the lecturer was totally unable to reply to it."

"Tell us, please, Mr. Johnson, what was written on the slip of paper."

"I have a better plan than that," was the reply. "Suppose we make a memory test of it. How many of you have pencils?"

About half of the boys raised their hands.

"It makes no difference," he said, "I brought enough pencils for all of you, as well as slips of paper on which you can write as much as

you can remember of what you hear. Now, I will slowly read this very curious matter, and will afterwards ask you to write on the slip of paper all you can remember of it. As this wag knew, it is much more difficult to remember nonsense than sense, so you must not be surprised if I read to your some very absurd English."

Mr. Johnson then read aloud the following charming piece of nonsense:

"So she went into the garden to cut a cabbage leaf to make an apple pie; and at the same time a great she bear, coming up the street, pops its head into the shop window. What; no soap? So he died and she very imprudently married the barber; and there were present at the wedding the pickaninnies and the Joblillies, and the Garallies, and the Grand Panjandrum himself, with the little round button at top, and they all fell to playing the game of "Catch as catch can," and they danced till the gunpowder ran out at the heels of their boots."

This matter was so ridiculous that the boys

shouted with laughter while it was being read to them.

"Now," said Mr. Johnson, "take the slips of paper, write your names on the top, and then write as nearly as you can remember the exact words in the order in which I recited them. I do not care what parts of the room you go to while writing, only, of course, you must not look on one another's papers."

Fred's paper showed the best memory, he being able to remember word for word all that had been recited. Bert came next, and Heinrich last. His knowledge of English was so poor, especially of the construction of the English sentence, that he was utterly unable to remember anything like an approach to the order of the words. Some of the boys got hold of his paper and were beginning to read, 'She into the garden went to make a cabbage leaf pie,' and were laughing at it, when Mr. Johnson good-naturedly took the paper away from them.

When Fred was announced to be the winner, the boys said:

"We could have told you that Fred would win; he is great on things of this kind, and none of us pretend to touch him."

"There is another kind of memory game, not unlike that which you have just had," said Mr. Johnson, "and although it is not quite as difficult, yet it is difficult enough. We will call this game, for want of a better name, the 'Game of the Good Fat Hen.' I want all the boys to stand in a straight row. I will then repeat a simple sentence in English which each boy will repeat after me word for word. While this will be hardest for the boy at the head of the line, since he will hear this sentence first, yet those further down, who will hear it repeated a number of times, must be careful not to be misled by the errors of the boys above them. Only the exact words, and in the order in which I give them, will be counted correct. As soon as a boy misses, either the words or their order, he must

go down to the end of the line. When he has been sent down to the end three times, he is out of the game."

The boys arranged themselves as requested, and Mr. Johnson said:

"A good fat hen," which all the boys repeated, one after another.

Then, beginning at the top of the line, Mr. Johnson said:

"Two ducks and a good fat hen," the boys repeating the words after him. Since the boys gave him close attention, there were no mistakes made on this second round. On the third round, Mr. Johnson said:

"Three squeaking wild geese, two ducks, and a good fat hen."

On this round several of the boys failed and were sent down to the end of the line. On the fourth round the words were as follows:

"Four hundred bushels of Limerick oysters; three squeaking wild geese; two ducks, and a good fat hen."

On this round four more boys were sent to the end of the line.

On the fifth round the words were:

"Five hundred Macedonian horsemen drawn up in battle array; four hundred bushels of Limerick oysters; three squeaking wild geese; two ducks, and a good fat hen."

On this round several boys were sent down to the end of the line for the third time, and were, therefore, declared out of the game.

On the sixth round the words were:

"Six, slick, slim, slippery snails, slowly slipping sidewise; five hundred Macedonian horsemen drawn up in battle array; four hundred bushels of Limerick oysters; three squeaking wild geese; two ducks, and a good fat hen."

On this round three more boys were declared out, thus leaving three standing.

On the seventh round the words were:

"Seven hundred elephantine elephants entering Ethiopia by the River Nile with the view of ascertaining the position of the pyramids and

supplying the inhabitants with Nile water; six slick, slim, slippery snails, slowly slipping sidewise; five hundred Macedonian horsemen drawn up in battle array; four hundred bushels of Limerick oysters; three squeaking wild geese; two ducks, and a good fat hen."

On this round, Fred was the only boy who succeeded in repeating all the words in the exact order. He was, therefore, again declared the winner of the memory test.

"Oh, there's no use in trying to beat Fred at memory games," said some of the boys good-naturedly.

"Then," said Mr. Johnson, "suppose we try some other kind of memory game. So far I have only tested you as regards the words you hear. I will now make a test of things that you see. This test may properly be called an observation-memory test. The power of observing things differs greatly with different people. With some there are but few things that escape their observation. Such people are able, by appar-

ently giving a mere glance at a number of different objects to remember every one of them, while others are unable to give any coherent account of what they have seen. It is said that Robert Houdin, the great French wizard, succeeded in many of his tricks by reason of the wonderful power he possessed of remembering objects he had only momentarily observed. He frequently visited the houses of the nobility in France for the purpose of giving private exhibitions of his skill. If, under these circumstances, he happened to be taken rapidly through a library in order to reach the room in which the exhibition was to be given, he obtained quickly a mental picture of the general appearance of the room, and then, while walking rapidly past the bookcases, concentrated his looks on a row of books on one of the shelves, so as to fix indelibly on his memory the location of this shelf, the order in which the books were arranged on it, the coloring of their binding, as well as their exact titles. Afterwards, during the entertainment,

he pretended to look through a magic telescope, formed by winding a sheet of newspaper into a hollow cylinder. Applying this to his eyes he would say:

" 'I will now show you a great feat in magic. With this wonderful telescope I have the power of looking through the walls of this house into a distant library. I will tell you just what I see there. But let me first say that I have never been in this room except that I was taken through it as rapidly as I could walk. I can distinctly see one, two, three, four large book-cases in the room, filled with books,' pretending to move the paper telescope as if pointing to different parts of the room. 'In the third book-case on the right hand side from the distant door, at which one enters the room, on the third shelf from the bottom, I see ten books. They are bound in the following colors: The first two are blue, the next three gray, the next white, and the others black. Their names, beginning with the blue books, are as follows:'

And then, in order to make the feat seem more realistic, he pretended to read off with difficulty the names of the books he had succeeded in deciphering as he rapidly passed them. When he had completed this list, he said:

" 'That you may know that I really see these books through this wonderful telescope, I will ask your host to appoint a committee to go and see whether there are such books in that part of the library.'

"Of course, when such a committee was appointed, it found the books of the exact colors, in the exact order, and with the names that he had given, thus increasing his already great fame.

"It is said that Houdin was in the habit of cultivating his power of observation by walking rapidly past a shop window filled with different kinds of small articles, and afterwards seeing how many of these articles he could correctly remember and write down on a sheet of paper. He had a son who afterwards proved to be an

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even greater magician than his father. In order to enable this lad to acquire this power of observation, he would frequently lead him rapidly past store windows, and then the two would enter into a generous rivalry as to which could remember the greatest number of objects. At first the father invariably won. Indeed, he was able to remember so many more objects than his son, that his son asked him once:

" 'Now, father, honest, are you treating me fair? Have you never passed that window before?'

" 'Never, my son. I can remember a greater number of objects than you only because I have cultivated my power of observation to a greater extent. You are much younger than I am, and when you have cultivated this power of memory longer, you will find that you can easily remember more than I can, for a younger mind is better able to remember things than an older one.'

"The trials were kept up for several weeks,

and then the boy found that he was able to remember many more objects than his father."

When he had finished telling this story, Mr. Johnson said to Bert:

"Albert, can you get me a small table? Oh, I see there is one in the corner. May I use it?"

"Certainly, I will take off the things that are on it."

"Now, boys," said Mr. Johnson, "please shut your eyes for a few moments until I arrange on the table some things that I have here."

When they were told to open their eyes, they saw that the table had been brought into the middle of the room, and a pocket handkerchief placed over some objects that he had arranged on the top of the table.

"Now draw your chairs around the table so that each may be able to get a good look when I remove the handkerchief, beneath which I have placed a number of small articles, with all of which I believe you are familiar. I want to say that neither Bert nor any of the boys

have any idea of the things I have placed on the table. As far as I know, they have never seen these articles in my possession. There are thirty-six different articles only. Where there are several articles of the same kind, on the table, be sure to give the number of such articles, since each in scoring will count one. When I remove the handkerchief, sit still, look as carefully as possible at the different things, but keep your mouths shut, and don't write anything on the sheets of paper I am going to give you. I wish you to remember these things only from seeing them, and not from hearing their names called out. I will give you exactly sixty seconds to observe. Then I will again cover the articles with the handkerchief and give you three minutes to write out the list of those articles you remember."

As soon as the boys were ready, the handkerchief was removed, and they all looked intently at the articles on the table for the sixty seconds allotted them.

At the end of this time, the handkerchief was again placed over the articles, and the boys as before were warned not to talk, but to go to any part of the room they chose, to write out the list of all the things they could remember having seen. At the end of the three minutes, Mr. Johnson said:

"Now, all must stop writing; fold the pieces of paper so that the writing comes on the inside, and sit again around the table. I am going to remove the handkerchief again, and give you five additional seconds to refresh your memory."

This was an unexpected move on the part of Mr. Johnson, and only the brighter boys made the most of it. Those of the boys, however, who did not possess the ability of concentrating their attention on an object, gained little or no advantage from it. When the handkerchief was again replaced, the boys were given half a minute to look over their papers and make such corrections or additions as they desired.

On the collection of the papers and their ex-

amination, Bert was found to be far ahead of all the boys in the number of things he had correctly remembered, his paper containing twenty-eight of the thirty-six articles. Patsy, to the great surprise of all the boys, and still greater surprise of himself, came third, having correctly remembered twenty objects.

Some of the boys were surprised at Bert winning over Fred. Some of the boys said to Mr. Johnson:

"We all thought Fred would be sure to win in this, as he did in the other tests."

"I am not surprised," said Mr. Johnson, "at Bert's winning this game, since the power of observation is a marked characteristic of one given to scientific studies. Indeed, if it did not happen that Fred is also a close student of natural science, the difference might have been even greater."

"Now, boys," continued Mr. Johnson, "it gives me much pleasure to give the two winners each a book as a prize. It so happens," he said,

laughing, "that I have selected two books on subjects in which I am especially interested."

With this, he handed Fred a book on elementary chemistry, and Bert a book on elementary geology.

"Since," he continued, "in after years you may be pleased to remember the circumstances under which you won these prizes, I will write the names of the winners in the books." Taking a fountain pen from his pocket, he then wrote each boy's name in the book he had received as a prize, adding it to the words, "Won at an observation-memory test held in Philadelphia, on—" (giving the date of the birthday party).

The boys were very much interested in the different memory tests, though many were both surprised and mortified at the poor showing they had made. Mr. Johnson, seeing this, said:

"Do not be discouraged. Many of you have done poorly probably because you have not yet tried properly to cultivate your memories. You

can easily see that a good memory may be a matter of considerable importance in after life, and that it will certainly pay you to endeavor to make yourselves strong in this direction."

It often happens that very small things in a boy's life tend greatly to alter his future career. That night several of the boys who had discovered that they were wofully deficient, either in their powers of observation, or in their ability to remember words, determined to improve themselves in this respect. Of these, at least three made marked improvements.

When the memory tests were completed, Mrs. Bridges invited Mr. Johnson and the boys to the dining room, where was served a little good-night refreshment of ice cream, strawberries, and cake.

CHAPTER IV

THE NEWSPAPER IN THE SCHOOLROOM

AMONG the many characteristics of Mr. Johnson that especially pleased the boys was the way he had of constantly employing new methods of teaching, thus assuring a freshness of impression that is so markedly absent in ordinary teaching.

"It can't get dull in his classes because one never knows what he is going to do next," said the boys among themselves.

One day shortly after Bert's birthday party, Mr. Johnson said to the class:

"I will not assign a lesson in geology for the next time. I shall, however, expect each boy to read carefully over what our text-book contains about volcanoes. If any of you have other books

on this subject, I would like to have you read them also, so as to find out all you can about volcanic action.''

On the day he had appointed for this lesson, Mr. Johnson brought into the classroom several illustrated newspapers containing descriptions of the then recent terrible volcanic eruption of Mount Vesuvius.

After reading the accounts of the eruption, he pinned the newspapers to the blackboard, and asked the boys to come up and examine the illustrations.

''In this way,'' he said, ''you can get some idea of what volcanic eruptions are, and the terrible damage they may cause. Can any of you point out on the map other portions of the world besides Italy where there are active volcanoes?''

This was successfully done by a number of the boys.

''Now, I would like one of you to tell me whether there are any peculiarities in the distri-

bution of volcanoes. You may tell me, Bridges,'' he added as several of the boys raised their hands.

Bert then mentioned the well-known fact that practically all the volcanoes of the world are situated near the ocean, or some other large body of water; the principal volcanic districts being on the borders of the Pacific; in the neighborhood of the seas that separate the Northern and the Southern continents; as in the Mediterranean Sea between Europe and Africa; in the Caribbean Sea between North and South America; and in the seas that lie between Southern Asia and Australia, and in parts of the Atlantic and Indian Oceans.

Mr. Johnson then pointed out these districts on a large map of the earth, and had various members of the class repeat them until they were thoroughly memorized.

''You now,'' he said, ''know *what* volcanoes are, and *where* they are situated. Let us try to find out *why* they are, or how they are caused. I

am sorry that the exact cause of volcanic activity is not entirely understood, although I believe the theory I am now about to give you is the one most generally accepted by scientific men. But before I go into the details of this theory, I want you to do some hard thinking for me. I wish each boy to think of a large mass of matter in the shape of a huge globe. Have you thought of it?"

"Yes, sir," said the boys with an increase of interest.

"Be sure to make it big enough. O'Connor, how big a globe have you thought of?"

"It's as big as our playground, sor," was the reply.

"Oh, that's not nearly big enough. Think of a larger globe. Heinrich, how big is the globe you are thinking of?"

"De globe dot iss in my head," said Heinrich, "iss von mile thick."

"Better," said Mr. Johnson, "but not yet big enough. Bridges, how large is the one you are thinking of?"

"It is somewhat larger than our earth is at present, sir," said Bert.

"Excellent. Now, boys, I want you to imagine the globe of which you are thinking to be the size of the earth, say about eight thousand miles in diameter. Imagine it to be heated throughout, so that all its materials are in a molten condition, and then suppose this globe to be placed somewhere in empty space where the temperature is very low. Of course, it will begin to cool. Will this cooling be greater on the inside or on the outside?"

"On the outside, of course," was the answer.

"Can any of you tell me whether matter generally occupies a larger space when it is hot or when it is cold?"

"When it is hot," was correctly answered.

"Well, then, you can easily see what would happen to our earth, if, a very long time ago, it had been heated throughout from its center to its outside, and was then permitted to cool. It would begin to shrink, growing smaller, and

thus would bring a great pressure on the inside. Every now and then this pressure or strain would become so great that portions of the crust would be cracked or broken, thus permitting some of the molten matter to escape. It is believed that the breaking out of this melted matter causes what we call volcanoes. As the earth's crust gradually became thicker, the eruptions were less frequent, but, at the same time, a great amount of force was required to form fissures in the crust. As the crust was cracked or fissured, there would be produced shakings or quakings, that cause what are called 'earthquakes.' Now can any boy tell me in his own words the cause of volcanoes?"

All hands were immediately raised.

"Tell me, O'Connor."

"Shall I use me own words intoirely, sor?" asked Patsy.

"Yes, O'Connor."

Patsy then gave, in his own words, a concise but correct statement of the cause of volcanoes.

It was an odd description, though fairly correct, and made the boys laugh heartily.

"That's not a bad description, O'Connor," said Mr. Johnson. "I am sure you understand it."

"That I do, sor, and I am glad to give it to you in me own words and not in the stupid way in which I answered ye the other day."

"Mr. Johnson," asked Bert, "is the interior of the earth still in a melted condition?"

"No, Bridges. So long a time has passed since the earth was completely melted throughout that it is now generally believed to be solid from the outside to the center."

"Then," said Bert, "how is it that melted material can escape from the interior?"

"That is very difficult to understand. It is, however, generally believed that it is to be correctly answered as follows: A liquid differs from a solid only in its particles being further apart. When a solid is heated it grows larger, or expands because its particles move to and

fro through greater distances and take up positions further apart. Although a solid may be highly heated, yet it cannot fuse unless there is room for its particles to take up positions further apart. Now, while it is believed that the material in the interior of the earth is hot enough to melt, yet it is so pressed on by the matter around it that there is not sufficient room in which this melting can occur, so that it remains in a solid state."

"Then, how does it melt?" inquired several of the boys.

"When the pressure or stress caused by the cooling and shrinking of the crust becomes sufficiently great some of this material is slowly forced from the interior toward the surface. As it slowly rises, and is thus relieved of some of the pressure, it melts or fuses, and so escapes through the fissures as fused rock or lava.

"That the volcanic mountain is formed by the ashes that are heaped up in layers around the crater can be seen where water has worn deep

gullies in the sides of the mountain; for here the separate layers can be distinctly seen on the sides of these gullies. Again, where volcanic mountains have been thrown up from the sea, the waters have in some cases washed away a large portion of the mountain, so that its structure can be easily seen.

"Can anyone tell me of an even better proof that the volcano is often formed entirely of material thrown out from the interior of the earth?"

One of the boys suggested that volcanic mountains have been formed during historical times.

"That is excellent," replied Mr. Johnson.

"The volcanic mountain of Fujiyama, Japan, is an example. This mountain is said to have been thrown up from the sea in a single night. A better example still is the volcano of Jorullo, in Mexico. This mountain did not exist before the year 1759. Just before this date, there lived in a section of Mexico noted for the growth of the finest cotton and indigo in the world, a

wealthy planter named Don Pedro Jorullo, who lived at his ease about eight miles from the Pacific Ocean and seventy miles southwest of the city of Valladolid, on a beautiful plantation that yielded him a large yearly income. Several months before the eruption, the inhabitants of this district were so frightened by repeated earthquake shocks that they ran out of their houses, but, nothing worse happening, they soon afterwards returned.

"The shocks were repeated at different intervals, until, on September 28th, they again occurred. And then, in addition to the shocks, there suddenly escaped from great fissures that were formed in the ground, streams of molten rock, that began to flow over the land. One of these streams ran into a river, where, after driving off the water as steam, it flowed through the channel as a stream of molten rock. At this eruption, there escaped from six cones or craters, formed on areas where formerly stood highly cultivated fields, such immense quantities

of molten rock and ashes that six huge mountain masses were rapidly formed, one of which, raised to the height of 4,265 feet above the level of the sea, forms the well-known volcano of Jorullo. In this manner, poor Don Pedro was completely ruined, his fertile estate being converted into valueless volcanic mountains.

"And, now," said Mr. Johnson, "let us look more closely into the peculiarities of volcanic action. There are three kinds of materials that escape from the craters: melted rock or lava, ashes or cinders, and vapors or gases, such as the vapor of water or sulphurous vapors. While some of the lava and ashes are carried great distances from the crater, the greater part collects directly around the crater, in this way building up a volcanic cone. During the quieter action of the volcano, the height of the mountain increases, but frequently, during severe eruptions, much of the mountain is torn down. This was the case in 1815, in the eruption of Tomboro, in the Malay Peninsula, when, during

a single violent eruption, the volcanic mountain was reduced from a height of two miles to less than half a mile."

"Does the lava run very rapidly down the sides of the mountain?" inquired one of the boys.

"When the lava first comes out of the crater it may, especially when thin or liquid, flow more rapidly down the mountain than a horse can gallop. Soon, however, a crust forms on the surface, and the mass flows more and more slowly until at last its motion can scarcely be perceived by the eye. The crust formed by the cooling of the lava, however, does not extend more than a short distance below the surface. Owing to the good non-conducting power of this crust for heat, the lava below the crust remains red hot for many years.

"In some cases, the lava stream continues to flow down the mountain-side inside of its cooled crust. When, therefore, the liquid lava finally reaches the lower part of the mountain, the

cooler outer part is left in the shape of a long funnel-shaped mass or cave. Generally, however, this afterwards breaks down, and settling into cavities, produces the rough and irregular surfaces that characterizes the lava fields.

"A hardened crust sometimes forms very rapidly on the surface of stiff lava. I remember reading about an English geologist who was so interested in watching a lava stream flow down a mountain that he failed to notice that the stream had divided, and that a wide stream not only passed back of him, but had united with the other stream, thus completely surrounding him by streams of the red hot rock, that were gradually encroaching on the place where he was standing. It looked at first as if he must perish, since the streams were too wide to cross by jumping. There was but one thing to do. If he remained where he was, the lava would engulf him; therefore, selecting a place where the stream had the least width, he attempted to pass over it by treading lightly on the thin

crust. To his great relief, he found the crust strong enough to bear him, although in several places it nearly broke, threatening to let him into the liquid mass below. As it was, he received no further damage than scorched clothes and burned shoe soles.''

''Does much lava escape at a single eruption?'' asked several of the boys.

''The quantity of lava that escapes from volcanic mountains in a single eruption is often very great. The islands of Hawaii and Iceland were formed entirely by lava streams that have escaped at different times from the craters of their many volcanoes.

''But still larger lava streams have flowed in the geological past over parts of Idaho, Oregon and Washington, in the United States. Here old lava fields exist that cover an area of thousands of square miles. O'Connor,'' said Mr. Johnson, suddenly stopping, ''how large do you suppose volcanic craters are?''

Having already made a mistake in thinking

of a globe the size of the playground, Patsy said:

"Bedad, sir, I do not know, I don't want to guess. But some of them must be very big to throw out so much stuff."

"You are right, O'Connor," said the teacher. "The craters of some volcanoes are very large. Kilauea, on the island of Hawaii, has a crater three miles long, and two miles wide. This crater is filled by a lake of lava that is surrounded by precipitous walls that are in places over a thousand feet high. Sometimes jets of very liquid lava are thrown up high into the air, which being caught by the wind, are drawn out into thin hair-like threads. The superstitious natives of Hawaii believe that these silk-like threads are hairs from the head of their goddess Pele. I have a specimen of the so-called 'Pele's hair' in this small bottle, and after the lesson I will give you an opportunity to examine it.

"Volcanic ashes or cinders consist of small

particles of liquid lava thrown high into the air and suddenly chilled. When very fine, these ashes form what is called volcanic dust. Sometimes dust clouds are produced that completely obscure the light of the sun, turning the day into night. It is the red light from the molten lava, reflected from these clouds, that produces the appearance of flames of fire."

"Are not volcanic eruptions generally accompanied by loud noises?" inquired Fred.

"Not always, Brown," said Mr. Johnson. "Sometimes the lava escapes so quietly that the only warning the people in the valleys below have of the eruption is a fire in the woods due to contact with the molten rock. In explosive eruptions, however, the sounds are sometimes very loud. In the eruption of Krakatoa, in 1883, the noise was so great that it was heard in all directions around the crater for a distance of two thousand miles. The volume of dust thrown out was sufficiently great to cover the earth's surface with dust

layers of perceptible thickness at a distance as great as a thousand miles from the volcano.

"During this eruption huge waves were set up in the waters of the ocean that extended completely around the world. The waves in the immediate neighborhood of the island were from fifty to eighty feet in height and swept over portions of Java and Sumatra, destroying some three hundred villages, and killing over thirty-six thousand people. In one instance, the waves carried a ship inland a distance of a mile and a half, leaving it stranded high and dry, thirty feet above the mean level of the sea.

"But the most curious thing about this eruption of Krakatoa, was the great height to which the finer portions of the dust and vapor were thrown. It has been estimated that these jets reached, in some cases, a height of from fifteen to sixteen miles. This dust, carried by the wind to all parts of the world, remaining suspended in the air for many months, produced the peculiar red sunsets that occurred

all over the world for many months after the eruption.

"We still have some time left," Mr. Johnson remarked. "Are there any questions about particular volcanoes that you would like to ask me?"

"Will you not tell us something about Herculaneum and Pompeii?" asked Bert.

"Yes. It will make a very interesting story, and will, besides, give me the opportunity of telling you something about the early history of Vesuvius.

"The first eruption of Vesuvius of which we have any record was in the year 79 A. D. This volcano had been extinct for so long a time that the people who were living on its slopes, where they were cultivating crops of grapes and other fruits in the rich soil formed by the general decomposition of the volcanic ashes, were apparently ignorant of the fact that they were living on a volcano that might at any time again become active.

"There were plenty of warnings so that the people might readily have escaped had they known enough of volcanic action. It is the common experience that many severe volcanic eruptions are preceded by strong earthquake shocks. In the case of Vesuvius, these shocks were felt as early as 63 A. D., continuing at irregular intervals, until the time of the eruption of 79 A. D., which I am about to describe.

"It may interest you to know that the Roman gladiator, Spartacus, with his little band of followers, who had escaped from their Roman masters, had a hiding place in the old crater of Vesuvius, which was then occupied by a lake, on the borders of which Spartacus and his followers had their camp. Betrayed to the Romans by one of his followers, Spartacus at one time was surrounded by a large body of Roman soldiers while encamping by the lake. He succeeded, however, in escaping with all his band by climbing up the vine-clad walls of the precipice surrounding the lake.

"We have an excellent description of this early eruption of Vesuvius written by the Roman historian, Pliny, who tells us that his uncle, the general, was stationed with the Roman fleet at Mycenum. When the eruption occurred, the general landed a party of his men and marched up the mountain, but both he and his band were destroyed by the stifling clouds of sulphur vapor that swept down the mountain.

"It was during this eruption of Vesuvius that the cities of Herculaneum and Pompeii were destroyed by showers of ashes and by mud streams. These cities, especially Pompeii, were not unlike our summer watering places, and many of the wealthier Romans who lived at Naples had villas in them.

"But there were other warnings for the people of Herculaneum and Pompeii, besides the earthquake shocks. Although there had been frequent rains, yet the vegetation began to die on the sides of the mountain. Springs and wells that had never before been known to become

dry, ceased to yield water. The heated rock was evidently being slowly forced up from great depths toward the surface.

Suddenly, on November 23, 79 A. D., the earthquake shocks again occurred, an awful explosion was heard, and there were suddenly thrown up in the air vast quantities of volcanic dust, red hot stones, and lava. A huge, dense, flat cloud spread over the sky above the mountain, obscuring the light of the sun. Amid lurid flashes of lightning, the frightened people could see streams of molten rock flowing swiftly down the sides of the mountain. From the glowing cloud, prodigious quantities of ashes and red hot stones were dropped down on the fertile country, destroying everything with which they came in contact. At the same time, an explosion blew off one side of the volcanic crater, thus permitting the escape of the lake which filled the crater. This water, together with a deluge of rain that accompanied the eruption, produced streams of mud that completely buried

the city of Herculaneum, while, at the same time, Pompeii was buried mainly by showers of ashes, though also partly by the mud streams.

"This early eruption of Vesuvius occurred during the reign of the Emperor Titus, who made efforts, on a large scale, to clear away the ashes and rebuild the city. The work, however, was so great that he finally abandoned it, and the city was permitted to remain buried in a mass of hardened mud and ashes, until its very site was forgotten.

"In 1592, the Italian architect, Fontana, while superintending the cutting of an aqueduct, came across some of the old buildings of Pompeii. This led to efforts to uncover the city, and, after that time, many unsystematic efforts were made for the same purpose. It was not, however, until 1860, that such efforts were successful, and now a great part of the old city of Pompeii has been again exposed to the light of day, so that it is possible to walk through its streets and to see many of its old houses and

shops. The streets are paved with slabs of lava that had escaped from Vesuvius during some previous eruption. These slabs show the deep ruts that had been worn in them by the wheels of the old Roman chariots.

"Herculaneum, situated about five miles from the city of Naples, was rediscovered in 1815, by a man digging a well near the village of Portici, when three very beautiful marble statues were unearthed. This same well was dug deeper in the year 1838, and the site of the old theatre of Herculaneum was unearthed. There have since been found, in both Herculaneum and Pompeii, many very beautiful marble statues, and in Herculaneum, some very interesting rolls of papyrus or sheets containing various written histories. Many of these sheets may be seen in the National Museum at Naples. Some of these have been unrolled and deciphered, but this is tedious work, owing to the fact that they are apt to break during the process."

CHAPTER V

SOME EXPERIMENTS IN EXPLOSIVE VOLCANIC ERUPTIONS

MR. JOHNSON continued to win the respect and esteem of the boys of the Mallory Academy, and its authorities, as well as many of the parents. Naturally enough, the boys talked so much at home about the strong points of their new teacher that many of their parents began to take a greater interest in this department of the Mallory Institute than they had previously done. This was especially the case at the homes of Bert and Fred, whose parents were desirous of having their boys thoroughly grounded in the physical sciences.

One day, shortly after Mr. Johnson's famous lecture on volcanoes, as Fred's mother had been

telling her husband about Mr. Johnson, and the wonderful interest he had awakened among the boys, Mr. Brown, who was a liberal man, and one who took a great interest in the progress not only of his own but of all boys, remarked:

"I think it might be well if we offered a prize to the pupil who passed the best examination in geology at the end of the present term."

"That would be an excellent idea," said his wife. "What will you offer as a prize?"

"I hardly know," said Mr. Brown. "I think it might be well if we go over to the Academy to-morrow morning and consult Dr. Mallory about the matter."

The next day, Mr. and Mrs. Brown called at the Academy about three-quarters of an hour before the morning session of the school and explained to the Doctor the plan they had in mind.

"You are very kind," said Dr. Mallory. "Mr. Johnson, the new teacher, has succeeded in awakening a wonderful interest among the boys

in the study of geology, and I shall be pleased to have you offer a prize to the student who shows the greatest progress in this branch at the end of the term. With your permission I think it might be best to consult Mr. Johnson, so as to determine the best conditions for awarding the prize."

Mr. Johnson was delighted when the idea of the prize offered by Mr. and Mrs. Brown was explained to him. When asked to suggest a plan for awarding it, he suggested that in determining the winner, reference should be made to the actual progress made in geology rather than the extent of the knowledge in this branch. He explained that were this not done, a few boys, such as Albert Bridges, were so far ahead of the others that the greater number of the class would have no chance at all in the competition.

"What would you suggest for a prize?" asked Mr. Brown of Dr. Mallory.

"I should, of course, prefer leaving that to you," was the reply.

"Well," said Mr. Brown, "I expect to take Mrs. Brown and Fred during the Christmas holidays on a trip through Florida, and the Florida Keys, returning by steamship to New York City. How would it do to offer to take along with us the boy who wins the prize?"

"That," said Dr. Mallory, greatly pleased, "would be an extremely liberal offer."

At this moment the bell rang for the opening exercises of the school.

"I must ask you to excuse me for a few moments," said Dr. Mallory. "But will you not come into the main schoolroom and sit on the platform during the opening exercises?"

"Certainly," said Mr. Brown, "and at the same time you can make the announcement of the proposed prize."

As will be readily understood the magnificent offer produced great excitement among the boys. While they all hoped to win the prize, yet most of them said to one another:

"There will be but little chance of winning this prize against Bert."

Mr. Johnson, who heard what the boys were saying, whispered something to Dr. Mallory, who said:

"I will afterwards explain more thoroughly to you the conditions on which the prize will be awarded. I wish to say now, however, that we will endeavor to make the conditions such that the actual progress made by a boy during his attendance in the class on geology will be taken into consideration rather than the amount of knowledge he possesses on the subject."

While passing to their different classrooms there was, of course, no little talking going on among the boys. Many of the boys crowded around Fred and said:

"Your father is all right, Fred. I am going to try to get the prize and go with you."

"I wish you success," said Fred to all such replies. "And if you win the prize and come along, I think we will have a jolly time."

"I hope you will try for the prize, Bert?" asked Fred.

"I certainly shall," said Bert. "A trip with you and your people through Florida and the Florida Keys would be great."

"Will you try for the prize, Patsy?" inquired Heinrich.

"Bedad," said Patsy, "Oi'll try all roight. Patsy O'Connor would be a happy boy if he could go all the way to Florida with Fred and his people, but I fear, Heinrich," he continued, "that Patsy's head is not big enough to win such a prize, but Oi'll try all the same. Will you try, Heinrich?" he continued.

"Yes," said Heinrich, "but I think dot prize is not for me."

The magnificence of the prize, together with the lecture on volcanoes by Mr. Johnson, produced an increased interest in the subject. The reading up of volcanoes extended from a few boys to every member of the class in geology. Not only were books of the Academy utilized,

as well as the books the boys found in their homes, or borrowed from their friends, but the libraries of the city were ransacked. Bert and Fred were especially diligent in this work, industriously reading anything they were able to find that bore, either directly or indirectly, on volcanoes. After each day's reading, they would talk over what they had learned in this manner, either while eating their lunch, at recess, or during their walk home.

One day, about a week from the date of the lecture, Bert said:

"Fred, I have come across a very odd class of volcanic eruptions. What would you think of a quiet volcanic eruption?"

"A quiet volcanic eruption!" said Fred laughing. "That is, indeed, an odd class. How can volcanic eruptions be quiet?"

"Only by comparison with very noisy or explosive eruptions," answered Bert. "Where the lava is not very liquid, it is thrown out from the crater explosively by the sudden formation

of steam, but where the lava is very liquid and the mountain high, as the melted rock slowly rises in the volcanic tube, the pressure against the sides of the mountain becomes so great that the mountain is split or cracked. Of course, the splitting of the sides of the mountain produces a slight shaking of the earth, but as soon as this is over the lava flows silently through the opening. This is called a 'quiet eruption.' "

"But, Bert, remember how thick the sides of a volcanic mountain must be at some distance below the surface. Do you think it probable that the pressure of liquid lava would be able to split the solid rock?"

"Yes; I think it would. The book I was reading says that a column of liquid lava five hundred feet high produces a pressure of six hundred and twenty-five pounds to the square inch. Now, quiet eruptions occur principally on high volcanic mountains, so that when the lava is forced up in the tube of a very high volcano, the

pressure on the sides would be sufficient to crack a wall of almost any thickness that could exist in an ordinary volcano:"

"I guess you are right," replied Fred. "But let me tell you what I have been reading about the chemical origin of volcanoes."

Before Fred could begin, Heinrich and Patsy joined them.

Heinrich's face glowed with satisfaction as he handed Fred a specimen of mineral he had in his hand.

"I wish you to see this specimen what I haf from a man in the city bought. Iss it not wonderful?"

"What is this, Heinrich?" said Fred, examining what was handed him. "It looks like a piece of dark green glass from a bottle or from a telegraph insulator. Has somebody been fooling you? How much did you pay for this piece of glass?"

"Vot iss dot you say?" demanded Heinrich excitedly. "That my so beautiful specimen is

nuddings but glass? I pay a half a dollar for him!"

"What," said Fred, "fifty cents for a piece of green glass?"

"Let me see it, Heinrich," said Bert laughing. "Don't you see Fred is kidding you?"

Heinrich handed his specimen to Bert, who, as soon as he looked at it, said:

"Heinrich, I congratulate you. It is obsidian or volcanic glass. You should by all means show it to Mr. Johnson. I am sure he would like to have the class see this beautiful specimen."

Heinrich was much pleased to learn that he had not been cheated, but had secured an excellent specimen.

"See here, Heinrich," said Bert, pointing to a sharp cutting edge on the specimen. "This kind of rock is frequently employed by the Mexicans for cutting tools. I remember reading about a hill in Mexico that was once regularly mined for this purpose. They call it in

Spanish 'Cerro de Navajos,' * which means 'the hill of knives.' "

"And now, Patsy," said Fred, "let me look at your specimen."

"Indade, Oi will not be afther showing it to you," said Patsy, "for I know that ye will be poking fun at me. Oi will show it to Bert, who will tell me what it is."

"Oh, come, Patsy," said Fred, good-naturedly, "you should be the last one to object to a joke!"

"Oi'll not deny that," said Patsy, "but Oi am intoirely too much in oirnest about this. Sure, and Oi bought it at the same place where Heinrich got his specimen, but I paid only ten cents for it."

Bert examined it and said:

"Patsy, what would you say if I told you that this specimen was of the same kind of material as Heinrich's, only in a different form?"

"Indade, thin, Bert," said Patsy, "Oi'm

* Pronounced Thāy-ro' de Nava'hos.

afraid that you are as bad as Fred. Can't Oi see that it is intoirely different? Heinrich's specimen is dark grane, while moine is almost white. Heinrich's is heavy, while moine will float on water, for Oi have tried it."

"Yes, Patsy," said Bert, "that is all right, but for all that the two materials are the same. What you have is a specimen of pumice stone, a kind of volcanic glass; in this specimen the fused material from which it was formed, instead of cooling in a solid mass, has had a great number of small air bubbles distributed through it, which changes its color and makes it so light that it will float on water."

"Oi'm much obliged to ye. Oi'll show my specimen to Misther Johnson."

"And now, Fred," said Bert, "please go on with what you were going to tell me as the boys came up. No," he added, as Heinrich and Patsy were about to leave, "it is nothing private; we are talking about volcanoes."

"Then," said Heinrich, "I will stay and I will learn more about volcanoes."

"So will I, bedad," said Patsy.

"I was reading a book," said Fred, "on the chemical theory of volcanoes. Instead of explaining volcanoes as caused by a heated mass that fills all the interior of an earth that was originally melted throughout, and has not yet completely cooled, it claims that the earth has completely cooled from the center to the outside, and that only here and there, at short distances below its surface, are masses of rock that have become fused by heat caused by chemical action. According to this theory, the lava does not come from very great depths, but from places comparatively near the surface."

"But where does the heat come from that melts the rocks?" inquired Bert. "I can understand that if all the earth was once heated, throughout, it might not yet have completely cooled, since the thick crust is composed of materials that are poor conductors of heat, but

I don't see that if the earth has once cooled, what could heat it locally at small distances below the surface."

"That's just what I was going to explain. According to the chemical theory, the interior is filled with substances that almost immediately become hot enough to fuse when brought into contact with water. When Sir Humphry Davy discovered potassium and sodium, he proposed a theory for the chemical origin of volcanoes. As is well known, when water is thrown on potassium or sodium, enough heat is liberated to fuse the material, large quantities of hydrogen gas being given off at the same time. Davy suggests that something like this might be the cause of volcanoes. If this were so, then large quantities of hydrogen gas should escape from volcanic craters during eruptions. In point of fact, however, there is little or no hydrogen gas liberated, so that Davy's theory was rejected. Now, the book I was reading says that substances have been lately discovered which not

only give out heat by contact with water, but also, while heated, have the power of taking in or absorbing large quantities of hydrogen gas. For example, certain chemical substances found in meteorites possess the power of absorbing as much as forty-seven times their volume of hydrogen gas. Now, if such substances existed in large quantities in the inside of the earth, as facts seem to show they do, should the water of the ocean come in contact with them, heat would be liberated, thus both producing volcanoes and accounting for their never being found far from the ocean."

"Fred," said Bert, "that is not a bad theory of volcanoes, is it?"

"It is not, indeed," was the reply.

Patsy was very much interested in what he had heard.

"Do you mane to say," he asked, "that there are koinds of stuff that will begin to burn when you throw water on them?"

"Yes, Patsy," said Fred. "A small piece of

potassium thrown into water will at once take fire. I have a small piece in this bottle," he said, taking a small bottle out of his pocket and showing it to Patsy.

"And phwat is the stuff in which it is placed?" inquired Patsy.

"That is coal oil," said Fred. "If the potassium was not covered with coal oil the oxygen would combine with it. If I had some water, I would show you this curious experiment."

"Thin," said Patsy, "Oi'll go and get ye some," and he soon returned with an old tomato can filled with water. Fred took out his penknife, and sticking it into the piece of potassium, drew it out of the bottle and sliced off a small edge.

"See," said Patsy, greatly excited, "it shoines loike silver."

As soon as Fred returned the large piece of potassium to the bottle and corked it up, he threw the smaller piece in the water.

"It's so light that it schwims," said Patsy, greatly excited when he saw the flames burst from the rapidly moving particle. "It is intoirely wonderful! It is in my moind to study chemistry as soon as I can."

"There are other substances," said Fred, "such as iron pyrites, a compound of iron and sulphur, that gradually become highly heated when exposed to air and moisture. But there is another substance, known as calcium carbide, a compound of calcium and carbon, that has been recently produced in the high temperature of the electric furnace, that produces large quantities of heat when thrown in water. This substance is now made in large quantities for producing the acetylene gas used for artificial lighting. I have a specimen of calcium carbide in my pocket," he said, taking out a small parcel wrapped in newspaper, unwrapping it and handing it to Patsy.

Bert laughed when Fred said he had some of the substance in his pocket, and remarked:

"Fred, you are a regular walking drug store!"

"And will this stuff give off gas when thrown in water?" asked Patsy.

"It will," replied Fred, throwing the specimen of carbide in the water in the tomato can. A great bubbling took place, and much gas was given off.

"Now," said Fred, "if a lighted match were touched to those bubbles they would burn with a bright light. Have any of you a match?"

It was a matter of great disappointment that none of them had a match.

"Well," said Fred, "that don't make any difference. I can light it with a bit of potassium." So saying, he again took the piece of potassium from the bottle, and cutting off a small particle, he threw it on the surface of the tomato can, when it immediately burst into flame, thereby lighting the gas that was being liberated by the calcium carbide. The experiment was a very curious one, and greatly excited the boys. It

seemed so odd that by throwing what appeared to be a piece of very heavy stone into water, one could instantly liberate a large volume of gas, that possessed the power of giving off light when set on fire.

"Dot iss very wonderful!" said Heinrich, shaking his head wisely.

"I say, Fred," exclaimed Bert, "that chemical theory seems to me a very beautiful theory of volcanoes. You say that calcium carbide is formed only under the influence of great heat. Now, this would be exactly the condition in which our earth was while highly heated throughout. It would not seem improbable, therefore, that large quantities of substances like calcium carbide do exist in the interior of the earth. Where did you get that specimen?"

"I got it in the city. You can get it at a number of places where it is sold to people who use acetylene gas for lighting their houses."

"Fred," said Bert, "let's try an experiment. Suppose we buy a few pounds of this stuff, dig

a hole in a corner of the playground, pour a lot of water on the material and set fire to the gas as it escapes, inviting the fellows to a private exhibition of a great experiment in volcanic eruptions?"

"A splendid idea," cried Fred. "We will try it. Let's go and talk it over."

As Bert and Fred went off, Patsy said to Heinrich:

"I say, Heinrich, why can't we get up a foine volcanic eruption and invite the boys to come and see it?"

"Dot vould be splendid," said Heinrich. "I haf got a big lot of gunpowder."

"And Oi belave Oi can get a small piece of dynamite," said Patsy, "for I know a man that works in the quarry. I don't know whether he will give it to me or not, but Oi belave Oi can get it."

"Dot will make a splendid experiment," said Heinrich, "and we will an invitation write to the boys, like Bert and Fred."

That afternoon, as our friends were on their way home from the Academy, it was agreed that Fred should purchase a few pounds of calcium carbide, and stop early in the morning for Bert, so that they could get on the playground and fix up their artificial volcano before the rest of the boys came to school.

"If we leave it till the boys are around, they will only be laughing at us," said Fred.

The next morning, when Fred called on Bert at the early hour appointed, he was carrying with him a tin can. It was of a much larger size than Bert expected.

"You don't mean to tell me that that can is full of calcium carbide?"

"Yes," said Fred, "I had to buy a twenty-five-pound can. They had sold all the smaller cans. The stuff is sealed in the can. They were unwilling to unseal it, since it soon spoils on exposure to moist air."

"All right," said Bert, "I will pay my half of the cost, as I agreed."

"Let's go at once so as to reach the playground before the rest of the boys come. But, before starting, can you get a spade and four boards about four feet long, and about the width of the can?"

"Yes, I can get them in the cellar," said Bert, "I will go at once." He soon returned carrying the boards and the spade.

On reaching the Academy grounds, the boys dug a hole about four feet deep in a corner of the playground. Fred punched a number of holes in the top of the tin can, placing it in the bottom of the hole with the holes uppermost. He then placed the four boards upright in the hole so as to form a rough wooden tube. Some of the soil was then packed around the outside of the boards, thus holding them in place, while the space above the can was loosely packed with pieces of brickbats and some pieces of stone that the boys brought from a pile in the corner of the playground. As soon as they were done, a board was placed over the top and the soil packed

down on it, so that one would not be apt to observe the position of the artificial volcano.

"You understand, Bert," said Fred, "it is necessary to keep the carbide covered with water when we are ready to make the experiment. By putting the can in the ground, with its open end upwards, and placing the boards around it so as to form a tube, and then filling the tube loosely with brickbats and pebbles, there will be a series of openings corresponding to the fissures in the crust of the earth. The top of the tube will correspond to the crater of the volcano. When we are ready to make the experiment, we will pour water down the tube, and as soon as enough of the gas has been thrown off to drive the air out from the tube, we will light it from the outside."

"I understand," said Bert. "I think it will make a beautiful experiment. We will invite the boys to come and see it. I guess we had better not say anything to our teachers about it, especially to Mr. Johnson, because the experi-

ment might not succeed and then we would be laughed at."

"All right, Bert. We will let only the boys know of it."

They got everything properly arranged before their schoolmates came into the playground. As they were leaving the hole, they saw Patsy and Heinrich coming to near where they had been working. They also had a spade with them, and commenced rapidly digging a hole in the earth.

"I wonder what they are doing," said Fred.

"I don't know. Probably some mischief which Patsy is up to. I guess it is nothing serious. Patsy's mischief is never of a mean kind. Generally there is a great deal of fun in it."

At the noon hour most of the boys were laughing as they came out of the school building at an invitation that had been prepared by Heinrich. It read as follows:

"O'Connor and Schmidt present their compli-

ments to their schoolmates, and ask the favor of their presence at a grand experimental volcanic eruption which will take place this afternoon in the playground at the close of the session. Be sure to come or you may miss something wonderful."

This written invitation from Patsy and Heinrich so closely following as it did, a verbal invitation from Bert and Fred, made no little stir among the boys, who crowded around Bert and Fred and Patsy and Heinrich.

"Tell us all about this experiment you are going to show us, Fred," they asked.

"Come and see," said Fred, nodding mysteriously.

When Patsy and Heinrich were asked the same question, Patsy said:

"Sure, and didn't the invitation say that it was a scientific experiment? It's no more than that Patsy O'Connor will tell ye! But be sure to come, or you may miss something intoirely wonderful."

"Dot iss so," said Heinrich. "Something great dot Patsy and I haf made out of our heads."

"Then it certainly should be something great!" said one of the boys laughing.

It should be said that when Patsy met Heinrich that morning he had showed him a small piece of dynamite.

"Sure and Oi had great trouble in getting this stuff," he said. "The man said it was too dangerous for a boy loike me to have. But I gave the man blarney, and Oi told him that my schoolmate, Heinrich Schmidt, was very learned and knew all about dynamite, so that there would be no danger."

"Dot iss so," said Heinrich proudly. "I haf much knowledge about dynamite. Let me have it."

Patsy drew a small piece of dynamite out of his pocket and gave it to Heinrich.

When the boys reached the playground, they dug a deep hole, carefully placed the dynamite

in the bottom of the hole, and then piled around it about a pound of gunpowder, inserting one end of a fuse that Heinrich said would require about three minutes when lighted to ignite the powder. The far end of the fuse was then placed above the ground, and then the hole cautiously but firmly packed with earth. As soon as this was done, a board was put over the place, and earth placed over it so as to hide the place where they had been digging.

"Vhen the boys at noon come out," said Heinrich, "I vill sit over the hole so that none of them can fire off the dynamite by jumping on the ground over it."

"Yes," replied Patsy, "that will be best."

At the close of the day's session nearly all the boys followed Fred and Bert to the place where they had arranged their artificial volcano.

"Now, boys," said Bert, "we will show you the great experiment of an artificial volcanic eruption produced by chemical action. Two of the boys have kindly agreed to bring us two

buckets of water. Here they come. Now, please stand back of this line, for there is no telling what may happen."

But the boys laughed and crowded far beyond the place where Bert declared it was safe.

"No," said Bert, "unless you stand where I ask, I will not take the responsibility of showing you this experiment."

"All right," said some of the larger boys. "Come, let's stand back and see the wonderful trick."

As soon as the boys drew back, Fred poured a bucketful of water down the wooden tube, and Bert followed with a second bucket. A bubbling sound was heard, and an unpleasant odor followed.

"Now," said Fred, "we must wait a while for the space above the can to be freed from air, or an explosive mixture of air and acetylene gas might be formed."

After a few minutes he applied a lighted match to the top of the tube, when the acetylene

gas ignited, making a bright and fairly large luminous jet above the top of the tube. After lighting the gas, both Fred and Bert stood back, knowing that there might be some explosion, and cautioned the boys against going anywhere near it. This advice proved to be excellent, for after a few minutes a mixture of air and acetylene gas collected in the wooden tube, and a muffled explosion was heard that threw a few of the smaller stones in the air. Fortunately, however, this did not extinguish the flames since, probably, the shaking of the ground caused the gas to be given off more rapidly, so that a brilliant flame again issued from the opening. Just how it was, is difficult to explain, but another explosion occurred about two minutes after the first, the gas again relighting, and then successive explosions followed one another at intervals of about a minute to a minute and a half.

It is probable that the decreased pressure produced by the ascending column caused enough air to be drawn through the ground to make ex-

plosive mixtures with the issuing acetylene. None of these explosions was severe enough to do any damage, and Bert and Fred's schoolmates all voted that the experiment of the volcanic eruption was a grand success.

"Hurrah for the boy geologist, and the boy chemist!" cried some of the boys when the experiment was about over at the end of nearly half an hour.

"And now," said Patsy, "come and see the great Schmidt-O'Connor volcanic eruption. We call it the eruption of Krakatoa."

"O Patsy," said one of the boys, "you are a crackerjack. You mean the explosion of a crackerjack."

"Oi don't care what ye call it. Come and see it."

As they were going to the place where Patsy and Heinrich had buried the dynamite and the gunpowder, Bert said to Patsy:

"Patsy, what are you going to show us? Are you sure that you have things right? Re-

member, there are a great many boys on the playground, and you might injure some of them if, indeed, you do not kill them."

"Don't throuble yourself," said Patsy. "It's intoirely harmless. We have only rammed a piece of dynamite and a pound or so of gunpowder down that hole, and we have a bit of a fuse that we will touch off with a match as soon as the boys gather around it."

Bert saw that the experiment about to be tried was exceedingly dangerous, owing to the great number of boys that had collected on the playground.

"Don't try the experiment, Patsy!" he begged. "Don't let him do it, Heinrich. You might kill yourselves or some of your schoolmates."

"Dere iss no danger," said Heinrich, smiling. But Bert explained to the older boys the great danger of the experiment, and some of them determined to prevent Heinrich from setting fire to the fuse, while others drove the rest

of the boys back a considerable distance from the opening. They were horrified, however, when Heinrich said with a satisfied smile:

"You gif yourselves worry too much. I haf two minutes to the fuse set fire, and she will in now one minute more already go off."

Seeing that no time was to be lost, several of the boys seized Heinrich and Patsy and forcibly dragged them away from the opening. Since their schoolmates knew that Bert and Fred were sensible boys, they believed that there was some danger they could not understand, and succeeded in getting all the boys at least two hundred feet from the opening, when suddenly there was a tremendous explosion, the earth was thrown upwards into the air for a considerable distance, and a large hole was torn in the ground.

The force of the explosion was so great that Dr. Mallory, Mr. Johnson, and several of the teachers, who had already been somewhat surprised at the milder and muffled shocks attend-

ing the experiment of Bert and Fred, came running out of the Academy where they had been holding a faculty meeting. Fortunately, no one was hurt, although if it had not been for the prompt action of Bert and Fred, many might have been killed. Patsy and Heinrich, greatly alarmed at what they had done, came to Bert and Fred and thanked them for having drawn them away.

"Indade," said Patsy, "nather Heinrich nor Oi dramed the explosion would be so great. But it was a Krakatoa, wasn't it?" he said proudly.

As we have already mentioned, the site selected by Bert and Fred for their experiment was near that selected by Patsy and Heinrich. It was probably by reason of the shaking of the ground that Bert and Fred's volcano, that had become partially extinct, again resumed activity, for while Dr. Mallory, Dr. Johnson, and the other teachers were on the ground, it again gave a mild explo-

sion, and a burst of flame came out of the crater.

"Good gracious," said Dr. Mallory. "What's that? Another explosion?"

"This, sir," said Bert, "is nothing serious. It is only a twenty-five pound can of calcium carbide that Fred and I have buried in the ground in order to test the probability of volcanic activity being due to chemical action."

"What does all this mean, boys?" asked Dr. Mallory, greatly mystified. "How did this occur?" he said, pointing to the hole that had been made in the ground by the explosion of the dynamite and gunpowder.

At this moment, Patsy, knowing that Bert would be placed in a disagreeable position of being obliged to tell about the "Krakatoa" explosion, explained to the Doctor just what he and Heinrich had done.

The Doctor looked grave, and severely reprimanded the boys, especially O'Connor and

Schmidt, pointing out to them the danger to which they had subjected their classmates.

"O'Connor, Schmidt, Bridges, and Brown will come to my office," he said, as he turned and walked away.

Those of the boys who waited until the interview was over, were pleased to learn that no severe punishment had been meted out to the boys, except that the Doctor had shown them how dangerous it was to make experiments of this character without first asking the advice of older heads. The boys, however, all agreed that both of the experimental demonstrations were great successes.

When the boys had left the study, Dr. Mallory, turning to Mr. Johnson, smilingly said:

"Mr. Johnson, there is certainly great enthusiasm among the boys on the subject of volcanoes, both by reason of your teachings, as well as by the Brown prize. Our librarian tells me that every book referring even remotely to the subject of volcanic action is in constant use."

CHAPTER VI

JACK HARDING, BULLY, COWARD AND THIEF

A FEW undesirable boys are generally to be found in all large schools. While the Mallory Academy was no exception in this respect, yet it contained, on the whole, fewer boys of an objectionable type than most schools of its kind. As soon as Dr. Mallory became convinced that any boy was inherently vicious he was promptly expelled, since, as the Doctor said, his school was not a reformatory, and he owed a duty to parents to protect, as far as possible from all evil influences, the boys they had entrusted to his care.

But it must not be supposed that the Doctor would promptly expel a boy who was merely mischievous. His long experience had enabled

him to distinguish between mischievous and vicious conduct.

"Mere playfulness," he said, "does not indicate vice. A boy may be almost constantly engaged in some kind of mischief, but provided it is good, clean mischief, it only shows that his energies have not been given sufficient opportunity to expend themselves in a better direction."

It was for this reason that he did not expel Patsy and Heinrich, and did not punish Bert and Fred severely for what they had done.

There was, at this time, in the Academy, a boy named John Harding. This boy was of the animal type, with a powerfully developed body and a feebly developed mind, a type that is unfortunately far from uncommon. While sometimes boys of this type, when properly trained, may develop into strong, vigorous men with a fair amount of mentality, yet, too frequently their mere animal instincts continue to predominate. Harding had developed into an

overgrown, lubberly boy, so backward in his studies that, although fully eighteen years of age, he was in one of the lower forms, the ages of the boys in which averaged not more than eleven or twelve years.

It is unfortunate for any school, but especially for a large school, to harbor a boy of the Harding type. It is, perhaps, never advisable to permit boys of eighteen to come into daily association with those of eleven or twelve; for, there are both mental and physiological differences that render such boys unsuitable as constant playmates. Harding, who was not only older, but also much larger and heavier than any of his classmates, took every opportunity, when there were no large boys around, to play the part of bully. He forced the smaller boys to run his errands, do his examples, and prepare his written exercises. Moreover, he levied a heavy tribute on them as regards the dainties they brought with them for lunch.

But what was much worse, he taught them

bad habits, such as cigarette smoking, and, in many cases, destroyed the purity of their young minds by loose and profane conversation, and bad habits.

Harding's bad influence in the school had been rapidly increasing. At the time of which we are writing, his bullying and tyrannous treatment of the smaller boys, not only in his own class, but among all the younger boys, had become so bad as to render the lives of some of the boys almost unbearable. It may be a matter of surprise to those unacquainted with the ideas of honor among youngsters that when Harding acted the part of a bully toward them, they did not tell the school authorities, or at least some of the older boys, so as to get them to fight their battles. But it was an unwritten law in the Academy, as, indeed, it is in most well-managed schools, that tale-bearing will not be tolerated under any circumstances, so the smaller boys kept their mouths shut and suffered in silence.

One day, on one of those rare occasions when

Bert and Fred were not together, Fred being at this time busy with some experiments in the chemical laboratory, Bert was walking across a part of the playground where the smaller boys generally collected, when he came across one who was crying bitterly.

"Hello! What's the matter, kid? Have you hurt yourself? Oh, I see now," he added, looking at the boy's face. "Been fighting, have you? Well, if the other boy did lick you, don't make a baby of yourself, and cry over it, but take your medicine like a man! It will be all over in a little while."

"I haven't been fighting," the youngster replied. "A great big coward of a boy has been thrashing me."

"He has, has he?" said Bert angrily. "A big boy thrashing a little fellow on the Mallory playground? Well, I will certainly see that *that* don't occur again. Tell me who he is, and if I can do it, I will thrash him so that he will never ill-treat you again."

"Please, Bert," said the boy, "I would rather not tell on him. You know Academy boys never tell on one another, and I don't want to begin now. I would rather take another thrashing than begin carrying tales."

"That's all right, generally speaking," said Bert, "but in a case like this, where a big lubberly fellow makes a cowardly attack on a little boy, he should not hesitate to tell his name. I will promise that it shall not be taken to the Doctor, and that none of the teachers shall know of it. All I want is a chance to teach him a lesson."

But the lad refused to betray his tormentor, so Bert slowly walked away, determining to watch and see for himself who the coward was. He had not gone far before he saw the youngster running away, followed by Harding, who easily caught him and again began to thrash him. Bert ran toward the two boys, and while approaching, heard Harding say:

"So you have been telling tales on me, have

you? I thought I had given you a good enough licking to keep you from doing such things, but I will give you now one of the worst you ever had in your life; and not only for that, but because you didn't bring me more cakes and pies from your home, as I told you to do the other day."

"But they wouldn't give me any," said the boy.

"Then why didn't you hook them?"

"You cowardly brute!" said Bert, running up to Harding. "Aren't you ashamed of yourself to strike a boy so much under your size, and to try to make him steal for you?"

"See here, Bridges," said the bully, "this is no business of yours. You had better get out, or I will give you a worse thrashing than I have given this youngster."

"You dirty coward!" said Bert. "Come and try it. I will give you a chance right here," taking off his coat.

"Yes," scornfully smiled the bully, "I see

what *you* are up to. You see Dr. Mallory coming across the playground, and you know that he won't let the fight go on, so you pretend you are not afraid to fight me."

"Very well," said Bert, "I will meet you to-day after school in the big field near the river where there will be nobody to stop the fight. You need a punishment for your cowardliness and mean conduct, and if I am able, I shall give it to you."

Bert said nothing about the approaching fight with Harding, even to Fred. The young lad, however, whom Harding had thrashed, spread the news far and wide, so that when Bert approached the field that afternoon, he found some fifteen or twenty of his particular friends awaiting him, while Harding, who was only able to number a few of the schoolboys among his followers, had invited some rowdies, with whom he had become acquainted outside of the school, to come and see him, as he expressed it, "lick a fellow." While approaching the field, Bert

heard Harding, who had arrived before him, telling the boys who were there just what he intended to do to him. Fred, Patsy and Heinrich were among these boys. Patsy was replying to Harding's bragging as Bert was approaching, and he heard the young Irishman say:

"So it's a good thrashing ye are going to give me friend Bert, is it? Now, listen to the advice Patsy O'Connor is going to give ye. Don't be too sure that the thrashing will be all on your side. My friend Bert is a good athlete, and Oi have seen him handle his fists with boys that are better than you; so Oi'm thinking that ye had better make arrangements with some of your friends to carry ye home afther Bert is through wid ye."

"Look out, Irish," said Harding, "or I will begin with you while I am waiting for your friend to arrive."

"Vot iss dot you say," exclaimed Heinrich angrily. "You must me thrash first before you begin to thrash mein frient Patsy!"

Harding did not say anything, but he looked as if the prospect of a battle with Heinrich did not please him, for he knew well that Heinrich was one of the strongest boys in the school, and was abundantly able to take care of himself in a fight.

As soon as Fred saw Bert approaching, he went to meet him, and said:

"Do you think you can manage this fellow, Bert? He is much larger than you, and they say he is very strong."

"I am not afraid of him," said Bert. "He looks big and strong, but has taken so little care of himself that I don't believe I will have any trouble in giving him the thrashing he deserves. Anyhow, I don't intend to permit the smaller boys of our Academy to be treated so shamefully without doing what I can to stop it."

"Well," said Fred, "if he licks you, I'll give him a chance at me, when he gets through."

"Now, Fred," said Bert, "you will, of course, be fair with him. If he licks me, and is willing

to fight you, then all right, but if he says he is used up, you must wait until another time."

"I guess you are right," said Fred reluctantly.

Bert threw off his coat and rolled up his sleeves.

"Bert has better arms than Harding," said some of the boys, noticing the well developed muscles, for it must be remembered that Bert was a good gymnast, and one of the best baseball players in the Academy.

"I think that Harding is going to get a thrashing," said another boy, in a low voice.

"I hope so," was the reply, in the same tone. "He deserves it right enough!"

"Wait," said some of the bigger boys as the two were getting ready to fight. "Let's understand that there is to be no striking below the belt, and no striking when a boy is down."

This was settled and the fight began. It was evident from the start that Harding knew nothing about boxing, and was outclassed by Bert.

All his practice in "the manly art" had been gained while bullying the small boys. With them his plan was, and so far it had always been successful, to make a rush at the boy and strike him anywhere, counting upon his greater weight and the smallness of his opponents.

But his adoption of this plan in the fight with Bert was very unsuccessful. Bert, quickly sidestepping when Harding rushed, landed his blows pretty nearly where he chose, so that the big fellow commenced very soon to show signs of punishment. His nose began to bleed, one of his eyes was nearly closed, and before long he presented a truly pitiable appearance.

Seeing that his plan of rushing was unsuccessful, Harding adopted more cautious tactics, but this resulted in his making no effort whatever except to ward off Bert's blows, which followed one another so rapidly that at last, to the great disgust of the boys, Harding began to blubber and to cry out that he had enough.

"Well," said Bert, "have you had enough?"

"Yes," replied Harding, "I've got enough."

"I've thrashed you, have I," asked Bert, "just as I promised?"

"Yes, you have," grumbled Harding, unwillingly enough.

"All right, then," said Bert, commencing to put on his coat. While doing this, he turned his back momentarily to Harding, who rushed at Bert and struck him a severe blow on the side of the head. Bert, however, was in such fine physical condition that the blow had comparatively little effect on him. This cowardly attack on Bert aroused great indignation, not only among his friends, but even among the rowdies who had come to back Harding, so that all the boys exclaimed:

"Give it to him hot, Bert! You haven't licked him enough!"

This advice was not needed, for Bert had already turned around and commenced giving Harding such a drubbing that the punishment he had already received was as nothing in com-

parison. The big fellow again commenced to blubber and to beg for mercy; but this time he pleaded in vain, and Bert kept at it until at last he said to Harding:

"Get down on your knees now and beg my pardon before the fellows for the cowardly attack you made on me."

Harding did this amid the jeering of the boys.

"Now," said Bert, "put on your coat and get out of this field, or I'll give you another dose."

On this, the cowardly fellow put on his coat and ran out of the field, looking back now and then to see whether Bert was following him.

As the boys walked home after the fight, Fred remarked:

"I am glad you thrashed the fellow the way you did. But look out, Bert. He will get even with you in some way. I noticed the look he gave you when you made him get on his knees and beg your pardon before the boys. If he ever gets a chance, I am sure he will play some dirty trick on you."

"Well, if he wants any more of the same medicine, I will give it to him," said Bert, quietly. "And, now, Fred, we must watch and see that he does not bully those little fellows any more."

The news of the fight spread rapidly among the boys of the Academy, who were all glad to hear that the bully had been so thoroughly punished; but it was especially among the smaller boys that the rejoicings were most sincere. Their great tyrant had met his master, and had received a good drubbing, so they took their revenge on Harding by writing in chalk on the fences and the walls of buildings around the Academy:

"Bert Bridges, Jack Harding's master," and in other places, "Who licked Jack Harding?"

Or, when these boys were together in crowds sufficient to protect themselves, they took pleasure in taunting Harding, saying:

"Look out, Harding, Bridges says he is going to give you another thrashing!"

Several months before the fight occurred between Harding and Bert, much petty thieving had been going on at the Academy. Efforts were made both by the authorities as well as by the boys themselves, to catch the thief, but so far all such efforts were unsuccessful, and the thieving had gone on greatly increasing. Enough, however, had been discovered to show that the thief was probably one of the boys of the school.

One morning Dr. Mallory spoke to the boys in the big assembly room after the opening exercises as follows:

"As you all know, there is a thief somewhere in this school. So far he has succeeded in escaping detection. Now, I want all of you to aid me in catching him. While I cannot be certain that the thief is one of our boys, yet I regret to say it seems only too probable that he is. If he is now in this room, and hears what I am saying, let me earnestly advise him to stop stealing at once and forever. It will only be a mat-

ter of time when he will be discovered, and then, as I need not tell you, there is but one thing for me to do, and that is to expel him from the Academy, thus branding him as a thief before the world. I want to say this to you, that no matter who the boy may be, no matter how good his previous record in the school may have seemed, I shall be obliged to take this course."

This address of the Doctor made so great an impression that some of the first form boys held a meeting after school to discuss plans for catching the thief, and thus taking away the disgrace from the Academy. Different plans were adopted. Among others, they received permission from the Doctor to bore holes in the floor of the room immediately over the one in which the boys hung up their coats and hats and to keep watch. This plan, however, was unsuccessful and the Doctor remarked to one of the teachers that it looked now as if it was certain the thief was one of the boys, who had thus be-

come acquainted with the plan adopted for his detection.

Harding, who had never forgiven Bert for the severe thrashing he had received, determined, if possible, to get even with him. To this end, he formed plan after plan, only, however, to abandon them when he thought them out in detail. At last, however, he devised a plan that seemed all right. This was to bring an accusation of theft against Bert under circumstances that would make it almost impossible for him to prove his innocence.

With this intent, he persuaded two of the smaller boys to place, each, a marked nickel in the pockets of the coats they left in the coat room. When this was done, while no one was looking, Harding abstracted these nickels from the two pockets, and one morning, when Bert was going into the assembly room, adroitly slipped them into the pocket of his coat without being detected. When the exercises for the morning were over, just before Dr. Mallory be-

gan to dismiss the boys to their different classrooms, Harding rose in his seat and in a loud voice said:

"Dr. Mallory, I am glad to say that I have discovered the thief. I distinctly saw him go into the cloak room and take something from the pockets of the coats of Earle and Simpson. He did this so quickly that I can't tell what he took, but I am sure he took something."

"Let me have the boy's name at once," said the Doctor sternly, "but are you sure you are correct? It is a most serious thing to bring an accusation of this kind against a classmate. Whom do you charge?"

There was a great stir among the boys, who all looked eagerly toward Harding.

"I charge Bert Bridges with being the thief," he said. "I saw him take something from the coat pockets of these boys."

"Dr. Mallory," said Bert, rising and speaking very distinctly, "what Harding says is entirely untrue. I have not been near the coats

of the two boys named. Harding makes this charge because last week I gave him a thrashing he richly deserved.''

''I do not for a moment believe you are capable of theft, Bridges,'' said the Doctor composedly, ''but the charge has been publicly made, and it must be publicly investigated. Earle and Simpson,'' continued the Doctor, ''go and see if anything has been taken from the pockets of your coats.''

There was a deep silence in the room as the boys returned after looking through their coats.

''Well,'' said the Doctor, ''did you miss anything?''

''Yes,'' said Earle, ''we each put a marked nickel in our coats. They are both gone. Mine was dated 1904, and was marked with a scratch right under the figure 9.''

''Describe yours, Simpson.''

''It was dated 1905, and is marked by a scratch above the figure 5,'' replied Simpson.

''And, Harding, you say you saw Bridges

take something from these boys' coats and put it in his pockets?"

"Yes," said Harding, "just a few minutes ago, as he left the coat room to come into the assembly room. Whatever he took he put in the left hand pocket of his coat," pointing to the pocket where he had slipped the two nickels.

"Dr. Mallory," said Bert, coming forward. "You can easily prove how false this charge is. Please examine my pockets."

The Doctor did so and was greatly surprised when he took out two nickels.

"This looks like a confirmation of Harding's testimony, Bridges," said the Doctor, judicially, "but let me examine the coins. Yes, this one is dated 1904, and is certainly marked below the figure 9, as Earle said; and the other, dated 1905, has a scratch above the figure 5."

He then handed the nickels to Earle and Simpson and said:

"Are these the nickels that you placed in your coats?"

Earle, who spoke first, said:

"Yes, sir, this is my nickel, but I do not for a moment believe that Bert has stolen it."

"Neither do I," said Simpson, after he had identified his nickel.

"The burden of proof now rests with you, Bridges," said Dr. Mallory, regretfully; "as you must see yourself, the appearances are greatly against you. I will give you a full week to clear up this matter. If, at the end of this time, you cannot satisfactorily explain the presence of the two marked coins in your pocket, I regret very much to say that I may be obliged publicly to expel you from the school."

When Dr. Mallory made this announcement, Mr. Johnson immediately arose and said to him:

"Although the appearances are against Bridges, yet I am certain that he is incapable of such a thing as theft."

"I trust that you are right, Mr. Johnson," replied the Doctor. "But I prefer not to discuss the matter any further at present."

There was very little done that day in the different classrooms in the way of study. The boys were a unit in their belief in the honesty of Bert. Fred expressed his sympathy for his friend and said:

"Bert, I will not insult you by saying that I believe you to be innocent. That goes without saying. I have little doubt that this is a trick played on you by Harding to get even with you for the thrashing that you gave him the other day. Of course, Bert, you must not say anything about this matter at home. Let's see how it turns out first."

"No; I shall not say anything to mother about it. It would nearly break her heart to hear that I was even suspected of stealing."

That day at recess, Fred had a long talk with Earle and Simpson, the two boys from whose pockets the marked coins had been taken.

"How did you come to think of placing the two marked nickels in your pockets?" he asked.

"Jack Harding told us he thought it would be a good thing to do," replied Earle.

"Aha!" said Fred to himself, "I guess I am getting on to it now. Has Harding said anything to you about these coins since they were found on Bridges," he asked aloud.

"No," was the answer, "except that he called Bert names and said, 'I'm glad the sneak has been caught. Now we will see whether Dr. Mallory will keep his word and expel him!' "

Fred now began to see the matter more clearly.

"By the way, boys," he said, "had you any thing else in your pockets this morning?"

"I hadn't," said Simpson.

"But I had," said Earle; "I had a handful of change. I am a little flush now," he said smiling. "I have an uncle visiting our house, who is very liberal with me."

"But was none of this taken?" asked Fred.

"No," said Earle, "only the marked nickel, which seemed to me very funny."

"So that the thief," said Fred, "whoever he was, must either have taken the marked nickel by mere chance, or else has removed all the money from the pocket, picked out the marked nickel, and put the rest of it back in the pocket again. Were there any other nickels there?"

"Yes," said Earle, "besides the marked nickel, there was one quarter, two ten-cent pieces, four nickels and five pennies."

"With all these pieces of money, it is not probable that the thief would get the marked nickel the first time he put his hand in the pocket," remarked Fred thoughtfully.

Since Simpson was present, Fred did not say anything more to Earle. Afterwards, however, he saw Earle when he was alone and said:

"Earle, you don't believe that Bridges stole this money from you, do you?"

"I am sure that he didn't," said the little fellow earnestly.

"Then help me and we will see if we can't prove Bert's innocence."

Fred then explained to Earle a plan to which we shall afterwards refer.

One week afterwards, in the assembly room, on the completion of the opening exercises, there was a dead silence as Dr. Mallory arose, and calling Bridges to the platform, said:

"Well, Bridges, the week I gave you has now passed. What proof have you that you are innocent?"

"Dr. Mallory," said Bert, in a firm and manly voice, "I have no proof except my word. I assure you that I am innocent of this charge that is brought against me."

"Then, Bridges," said Dr. Mallory, most unwillingly, "I regret that I shall be obliged to expel you from the school. But before I do so, I will ask whether any boy in this room knows anything concerning this theft. If he does, I earnestly beg that he will let me hear from him, and so shield a schoolmate from this charge, if it happens that he is innocent."

Fred immediately arose and said:

this chemical, I sewed in a false pocket. We then placed the seventy cents in the pocket, first taking the precaution to mark each piece and left the coat in the room.

"This money has been in Earle's pocket for now nearly a week. It has not been touched until to-day. Now, however, it is gone; for I have just seen Earle, who tells me that the pocket is empty. I, therefore, believe that the thief who stole the money is now in this room. If he is, you will find his fingers colored with methyl violet, especially if he has tried to wash the coloring matter off, and I believe that you will find these marks on Harding's hands."

There was intense excitement among the boys at Fred's recital, and no little smiling at the clever trick he had played on the thief, if there had been one. All eyes were turnd toward Harding, who at once thrust his hands deep into his trousers' pockets.

"Come here, Harding" said the Doctor. "Take your hands out of your pockets."

Harding did so, and the Doctor saw that they were deeply dyed with a violet blue color. It was evident that he had tried to wipe off the marks as soon as Fred commenced telling the story, wetting his fingers with his tongue, for his lips were also stained a blue color.

"How did you get those marks on your hand?" the Doctor asked.

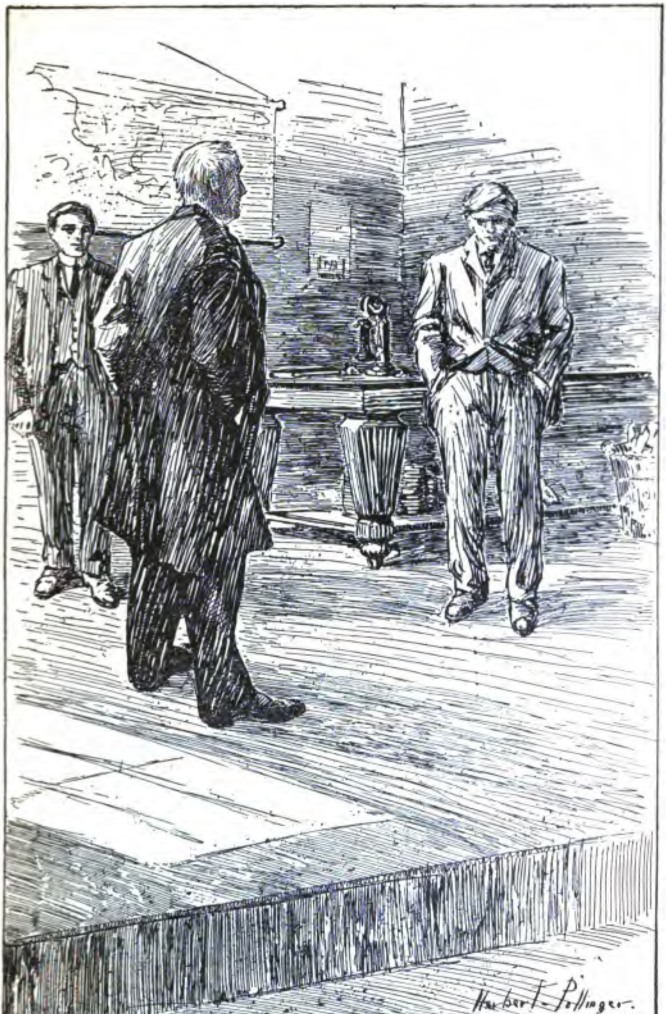
"I got them sharpening a blue pencil," was the reply.

"Doctor," said Fred, "the money has disappeared. Here is a list of the separate coins that Earle had placed in his pocket with their dates and the marks. I think if you look in Harding's pocket you will find the money there."

"Harding," said the Doctor, "turn out the pockets of your clothes."

Great beads of perspiration had come out on Harding's face, and he assumed an appearance of abject terror.

"I refuse to do so!" he cried. "It is insulting to bring such a charge against a boy like me."



" 'COME, TURN OUT YOUR POCKETS' "

"Come, turn out your pockets," sternly repeated the Doctor.

"I won't do it and won't let anybody else do it!" said Harding, defiantly.

The Doctor then asked several of the teachers to examine Harding's pockets, and on doing so only after a struggle there were found in the pocket of his coat, pieces of money agreeing in value, dates and markings with the list that Fred had handed the Doctor.

"Harding," said the Doctor, severely, "you are, I believe, justly convicted of being a thief. What have you to say for yourself?"

"I can't deny it," blubbered the boy; "but I never stole before. Dr. Mallory, I beg that you will pass it over this time. You will ruin my reputation for life if you drive me out of the school."

"Tell me now," said Dr. Mallory, sternly, "did you not, after persuading Earle and Simpson to place the marked nickels in their pockets, take them from their pockets your-

self and slip them unobserved into Bert's pocket?"

"Yes, I did," replied Harding. "I wanted to get even with him for something he did to me."

"Well," said the Doctor. "I shall publicly expel you from the school; but before doing so, I must see your parents, and have you return, as far as possible, the different articles that you have stolen."

"I will do it, sir," said Harding, whining, "if you will only pardon me. I hid many of these articles in the playground by burying them. Most of the money I spent, so I can't return that."

"And now, Bridges," said the Doctor, "you have been completely exonerated from this dreadful charge. I wish to ask your pardon before all the boys for having even suspected you of this action. I think, however, that you will agree that the appearances were greatly against you, and I hope that you will believe that I felt I must expel you so as to do the best

I could for the interest of the boys in this school. Will you pardon me for what I have done?"

"Certainly, Doctor," said Bert. "The appearances were, of course, against me. I have no feeling whatever against you, and believe that you only acted as you thought was best for the good of the school."

The Doctor, seeing that the boys were so excited that no work could be done that day, said:

"Boys, under the circumstances, I think I am justified in giving you a day's freedom. We will not resume school work until to-morrow morning at the usual hour."

This announcement was received with joy by all the boys, who, together with the teachers, at once crowded around Bert, congratulating him on his complete exoneration.

Afterwards on the playground the boys surrounded Fred and asked him to tell them something about the chemical that he had used.

"That was a capital trick you played on the

thief, Fred," they said. "You are all right! Can you show us some of that stuff you used?"

"Yes," said Fred, taking a small bottle from his pocket. "This stuff, when you once get it on your hands, is like 'Aunt Jemima's' famous plaster. The more you try to rub it off, the more it sticks the faster. A quantity of this substance so small that it might be placed on the head of an ordinary pin, possesses such intense coloring power that it can deeply color a bucketful of water."

"Let's try it," said one of the boys. "Wait, I will get the water."

As soon as the water was brought to Fred, he placed a small quantity of the chemical in the water and stirred it with a broomstick. They were all surprised to find that it colored all the water in the bucket a deep blue.

There were great times on the playground at the Academy during the morning. Among other things, a game of baseball was played by

two picked teams. By the afternoon, most of the boys had gone home.

Bert invited Fred to go home with him.

"I must now tell mother all about this matter, and would like you to be present," so Fred went home with Bert.

Mrs. Bridges was much moved when she was informed of the terrible charge that had been brought against Bert. Turning to Fred, she said:

"Albert and I are both deeply indebted to you for what you have so cleverly done."

"Please don't say anything about it," said Fred. "I am only too glad to have been able to do this for Bert, for there is no boy in the school of whom I think so much."

CHAPTER VII

THE GREAT SAN FRANCISCO EARTHQUAKE

IN the meanwhile, interest in the study of geology had steadily grown. Indeed, this interest was so great that the class had been increased by the addition of six new students.

It was unusual for Dr. Mallory to allow a class that had been studying a subject for some time to admit new members, since the students would be apt to keep back the others, but when Mr. Johnson offered to give all applicants special instruction after school, and to admit only those who were able to pass an examination on the matter already studied by the old class, Dr. Mallory gave his consent.

A few days after the earthquake at San Fran-

cisco, in April, 1906, which, with its attendant fires caused so great a loss of property and life, Mr. Johnson brought a number of newspapers into the classroom and remarked:

"I think we can profitably spend this hour reading accounts of the San Francisco earthquake, and, at the same time, review what we have already studied about earthquake phenomena."

An interesting half hour was spent in reading the newspapers, in which, among other things, attention was called to the location of San Francisco on the coast of the Pacific, in a region lying directly in a belt of active volcanoes almost girdling the earth. The city is situated on San Francisco Bay, one of the most magnificent harbors in the world. A part of the city was built on land that has a mean elevation of about thirty feet above the mean level of the sea. A large portion, however, was built on land formed by filling in mud flats and sand banks. It was in the latter localities that

the greatest destruction was caused by the shocks. A brief description was then given of the area shaken, the number of houses destroyed, the number of deaths, loss of property, and so on.

"You must not suppose," said Mr. Johnson, "that the earthquake at San Francisco, great as it was, has never been equaled. On the contrary, when compared with some other earthquakes, it was comparatively unimportant. Take, for example, the earthquake that destroyed the city of Lisbon, in 1755. This city, the capital of Portugal, is built on a number of small islands near the mouth of the Tagus River. Together with its suburbs, Lisbon extends a distance of nearly five miles along the banks of the river. The city is supplied with water by the great Elcantara Aqueduct, which brings the water a distance of some nine miles. Portions of the aqueduct are placed underground, while the part that extends across the deep valley of the Elcantara, a distance of fully half

a mile, is supported on twenty-five marble arches. In their highest portions, the arches are two hundred and sixty feet high. It is an interesting fact that a portion of the arches remained uninjured after the earthquake.

"The Lisbon earthquake occurred on a holiday, when most of the people were in the churches. The earthquake began with subterranean sounds accompanied by a loud explosion. Then the earth was suddenly shaken, most of the large buildings being thrown to the ground, thus killing great numbers of the people, while many who escaped the falling buildings were killed by fires that broke out afterwards, or were murdered by lawless bands that pillaged the ruins.

"During this earthquake, the ground rose and fell like the waves of the sea. Huge fissures were opened in the earth, into which some of the buildings were precipitated. An immense wave, over fifty feet in height, was formed in the ocean, the harbor being left dry for a

moment, when the water rushed toward the land with frightful violence. This occurred several times, thousands of people being drowned.

"The area shaken by the Lisbon earthquake was very great. On the north the disturbance reached as far as Sweden, solid mountain ranges, such as the Pyrenees and the Alps, being shaken, and deep openings made in the ground in France. On the south, the entire Mediterranean Sea was shaken; earthquake waves starting at Lisbon and crossing the Mediterranean destroyed a number of villages in the Barbary States. Toward the west, the disturbances crossed the Atlantic Ocean and extended as far west as the Great Lakes, in the United States.

"Earthquakes are especially frequent in volcanic regions, especially where the volcanoes are partially extinct. No part of the earth, however, is entirely free from these disturbances, but they are more frequent in mountainous dis-

tricts than in plains, especially in the neighborhood of mountains that are still being gradually elevated.

"There is the same uncertainty as to the causes of earthquakes that exists respecting the causes of volcanoes. It is generally believed, however, that, like volcanoes, earthquakes are due to the gradually increasing stress produced by the cooling of the earth's crust, and this, whether the heated mass that is cooling fills the entire interior of the earth, or whether it is the cooling of only a small mass that has been heated by local chemical action. As the cooling crust shrinks, the stress gradually increases, until it becomes sufficiently great to rupture the crust, the rupture being attended by an earthquake or a shaking of the crust. The force causing the earthquake may go on increasing for many years, the solid crust being so strong as to be able to resist breaking for a very long time. At last, however, the crust yields, and a sudden and severe earthquake is produced.

"But besides this, another and probably the principal indirect cause of earthquakes is the slipping of huge masses of rocks at places of faults where the crust is broken, and one part of the inclined strata raised at the break above the other part. When, now, from any cause, such a mass of rocks slips or slides to a lower level, a shaking of the earth's crust occurs, thus producing an earthquake.

"Earthquakes are, therefore, of two classes: volcanic earthquakes, or those directly due to the same forces that cause volcanoes; and tectonic earthquakes, that is, slip or displacement earthquakes, or those due to the slipping of a part of the earth's strata."

"Mr. Johnson," inquired Bert, "which of these classes caused the San Francisco earthquake; is it known?"

"There is no doubt," replied Mr. Johnson, "that the San Francisco earthquake was a tectonic quake due to a slip in the crust. Indeed, a fissure has been found that marks the place

where at least one of these slips, if not the principal slip, first occurred.

"While it is true," continued Mr. Johnson, "that the greater number of earthquakes start along lines of faulting, yet it is probable that the direct cause, or that which primarily produces the earthquakes, is the force produced by the contraction of a cooling crust, since without this force there would be no differences of level, at least no inclined strata, the slipping of which could cause the quake, and, indeed, in perhaps many cases no force sufficient to make the inclined strata begin to slip.

"If this theory of a gradually cooling crust be true," continued Mr. Johnson, "the crust of the earth must every now and then be in such a strained condition that a slight increase of pressure from within, or a slight decrease of pressure from without, must result in its fracture. While, of course, this fracture may occur at any time, yet, as a result of the careful study of all recorded earthquakes, it has been found

that shocks occur more frequently at night than during the day, more frequently in winter than in summer, and that they are more apt to occur about the time of the new moon or full moon, than at any other phase, that is, at those times when the sun and moon are so situated as regards the earth that they simultaneously produce a pull in the same direction on the same parts of the earth, thus adding to the gradually increasing strain.

"Can any of you tell me how these facts agree with the supposition that earthquakes are due to the forces produced by the gradual cooling of the earth's crust?" inquired Mr. Johnson of the boys.

Bert at once raised his hand.

"Well, Bridges, tell me."

"It would seem," said Bert, "if an earthquake is due to a force produced by the cooling of a heated portion of the crust, that while such force might become sufficiently strong to break the crust at any time, the chances of this

point being reached would be greater during such times when the cooling is going on more rapidly, and this, of course, would be either at night or during the winter."

"That is very good, Bridges," said Mr. Johnson. "But what about the new and the full moon? Why should the shocks be more frequent at such times?"

"I suppose, sir," answered Bert, "for the same reason. It makes no difference what causes the increase of the force. During the new and the full moon the sun and the moon act simultaneously on the same part of the earth's crust, so that at such times, the pressure would be more apt to reach the breaking point than at any other time."

"That is correct," said Mr. Johnson. "Would any of you like to ask me any questions?"

"Are there any other theories of earthquakes, just as there are for volcanoes?" asked one of the boys.

"Yes; earthquakes are now very generally be-

lieved to be sometimes due to a large quantity of water suddenly coming in contact with a large mass of highly heated material below the earth's crust, the steam thus suddenly formed producing a violent trembling of the earth."

"Mr. Johnson," said Bert, "is it known whether the place from which the shock starts is comparatively near the surface of the earth, or is it at considerable distances below the surface?"

"I am glad that you asked that question, Bridges. It was formerly believed that most shocks started at a considerable distance below the surface. It is now, however, generally believed that this point is comparatively near the surface. This fact had been determined by studying the effects produced by earthquake waves in the surface. In this manner, Mallet has shown that this distance is practically never further than thirty miles below the surface, and that, in some cases, it is only six or seven miles from the surface. It has been asserted as re-

gards volcanoes that the part of the crust from which the molten rock comes is never situated at very great depths below the surface. This you will remember was the reason for the chemical theory of volcanoes being proposed by Davy, a theory," he said, looking at the class and smiling, "that has been experimentally demonstrated on our playground not only by Bridges and Brown on a purely chemical basis, but also by O'Connor and Schmidt on the basis of local explosions."

There was a laugh among the boys at the expense of both Bert and Fred and Patsy and Heinrich, when this reference was made to their recent experiments.

"Mr. Johnson," inquired Bert, "if I understand you, earthquakes may occur at any time, may they not?"

"Yes, Brown, at any moment. We may have one before we leave our class to-day, but I do not think it is probable."

"Are there any signs by means of which the coming of an earthquake can be predicted?"

asked Fred. "I remember your telling us while describing the first recorded eruption of Mount Vesuvius that the people might have known that the eruption was about to take place by the dying vegetation and the drying up of springs as the lava was slowly forced toward the surface."

"I hardly know how to answer your question, Brown," said Mr. Johnson "There can be no doubt that there are indications of coming earthquakes; for, it has been observed, in countries where these shocks are common, that a great dread seizes wild animals, who, immediately before an earthquake shock, seek the companionship of man. The great English geologist, Sir Charles Lyell, asserts that marked climatic irregularities, such as violent rains at unusual seasons, and marked reddening of the disc of the sun, thus indicating the escape into the air of finely divided particles of dust or vapor, occur immediately before an earthquake. Besides this, earthquake shocks are preceded by a rumbling sound like the running of car-

riages over cobble stones, or by even more violent sounds like peals of distant thunder. But, in addition to indications that man is capable of noticing, it is possible that there are others which are readily detected by the more highly developed senses of animals. Of course, Brown, we must remember that the slowly accumulating force caused in any way, may need only an exceedingly small addition to enable it to act. For example, it has been noticed that marked changes in the atmospheric pressure as indicated by a high or low barometer, especially the latter, may determine the time of the rupture of the crust."

"I think I understand," said Fred; "it is on the principle that it is 'the last straw that breaks the camel's back.'"

"Yes and no," said Mr. Johnson, smiling. "Of course, you know that it is not the last straw that breaks the camel's back, but the last straw added to the weight of all the other straws that have already been piled on that does the work.

So it is not the slight difference in the stress produced by a change in barometric pressure, but this slight force added to the force that has already been accumulating.

"It takes but a very short time for an earthquake to produce its destructive effects. In the case of the Lisbon earthquake, in 1755, the shock which caused the greatest destruction, lasted only five or six seconds. A number of terrible movements of the crust, however, followed one another at short intervals after the first shock. It was the same with the San Francisco earthquake. There was first one terrific shock, exceedingly brief in duration, followed by a number of less severe shocks. Now, I would like to ask if any of you can tell me whether this fact would agree with the assumption that earthquakes are caused by a gradual accumulation of the force which breaks the rocks."

Bert was the only boy who was ready to give the explanation.

"Well, Bridges, let's have your explanation," said Mr. Johnson.

"Why, Mr. Johnson, it seems to me that the worst shock should be the first, since it is caused by the force that has been so long accumulating. The following shocks would naturally be weaker, since the crust has then been fractured. Probably, many of the later shocks are due to the settling of the broken up crust. I understand that these shocks are likely to take place weeks, months, or even years after the first one."

"That is a very good explanation, Bridges."

One of the boys asked for information about the noises or sounds that accompany earthquakes, while another wanted to know about the different kinds of movements produced in the crust.

"The sounds produced by earthquakes," said Mr. Johnson, "are of various kinds. There are terrifying sounds of exceedingly great intensity. If you recall the peculiar noise that is produced

by the rapid tearing of a yard or so of any fabric, such as calico, you can form some idea of the kind of noises heard during a severe earthquake, where, instead of a few yards of cloth being torn, probably miles and miles of solid rock are forcibly torn asunder. In addition, there are sounds resembling loud peals of thunder, or the discharge of heavy artillery. Then, too, there are frequently heard hissing sounds as if thousands of tons of red hot coals were being thrown into water.

"As regards the different kinds of motions produced in the earth's crust by earthquakes, in some cases objects are thrown vertically upwards, especially when they are immediately above that point in the crust where the earthquake shock begins. An account is given of an earthquake in South America in which a number of people were actually thrown across a moderately wide river. This, however, may be an exaggerated story.

"Curious changes of position sometimes occur

during earthquakes. Lyell mentions an odd occurrence during an earthquake in Italy, in which an extensive olive orchard was carried by the force of the shock two hundred feet into a neighboring valley. Strange to relate, several small inhabited houses standing on this ground, were carried away without injury. The motion did not at all injure the olive trees, which continued to grow in their new position and in the same year bore a large crop.

"Now, I know," said Mr. Johnson, "that most of you have been reading considerably on the subject of volcanoes and earthquakes. I would like any of you to give the class some of the facts that particularly impressed you."

This was a plan that Mr. Johnson frequently employed, since to the interest the boys themselves would take in their reading would be added the probability of being called on to impart such knowledge to their classmates. There were, consequently, a number of boys who were ready to give such information.

"I have read," said one of the boys, "that the crackling noises heard in a stove pipe when a fire is first lighted are of the same nature as earthquakes, such sounds being caused by the unequal expansion of the different parts of the pipe."

"Yes, these might properly be called miniature earthquakes."

"Or stovepipe quakes, bedad," whispered Patsy to the boys next to him.

"I read," said another boy, "that it frequently happens when very severe shocks occur in the neighborhood of large bodies of water, great quantities of dead fish are afterwards found floating on the surface. I suppose, sir, this is on the same principle that when dynamite or any other high explosive is ignited below the surface of a body of water, the shock given to the water will kill a great number of the fish."

"Yes," replied Mr. Johnson, "and this is why fishing by the aid of high explosives has been forbidden by law, since its general employment

would soon lead to the complete destruction of our fish supply.

"Bridges," asked the teacher, seeing that Bert had something to tell, but was waiting to give the other boys a chance, "what additional facts can you tell us concerning earthquakes?"

"I remember reading," answered Bert, "something about earthquakes that seemed to me very strange. After the occurrence of an earthquake, a number of conical crater-like openings were found in the soil of a marsh. In most cases, these openings were filled with water, thus forming miniature lakes, the borders of which were fringed with numerous cracks or crevices. In some instances, where the water was absent, a conical tube, gradually decreasing in diameter from the top to the bottom, was observed. I was much puzzled about this, and could not imagine the cause, but afterwards I found in another book that it was capable of a very simple explanation."

"Let's have the explanation, Bridges."

"During the movements caused by the earthquake, the ground was suddenly compressed or squeezed together, thus throwing jets of water into the air. These jets formed the conical shaped openings in the ground. In most cases, the water ran in from the surrounding soil, thus forming the small lakes."

"That is the correct explanation, Bridges," said Mr. Johnson. "Now, Brown," he continued, "can't you tell something about earthquakes in the line of your favorite study of chemistry?"

"I have read," answered Brown, "that it is a very common occurrence during an earthquake for sulphurous and other gases to escape from the ground. I was wondering whether it was not possible that animals received their warnings of approaching shocks by their ability to detect odors that are too faint to be perceived by man."

"I think it very probable, Brown," was the reply.

"Mr. Johnson," said Bert, "what is an earthquake recorder? I saw it mentioned in a book?"

"An earthquake recorder, or, as it is sometimes called, a seismometer, is an instrument for recording the number, duration and relative intensity of shocks. In its earlier form, as it was invented by the Chinese as early as 136 A. D., the instrument depended for its operation on the fact that the direction in which a tall pillar or column falls, when thrown down by the shaking of the earth, depends on the direction from which the shock reaches it. This early instrument was so constructed that the pillar was placed so as to be free to fall in eight different directions. The instrument was provided with a covering so arranged as not to interfere with the fall of the column. This cover had eight openings in the form of dragon heads, the mouths of the dragons being placed immediately above eight stone frogs. On the occurrence of an earthquake, a ball struck by the falling of the column was thrown out of a dragon's mouth

and, falling into the mouth of the stone frog, immediately below it, caused the frog to vibrate or shake, thus indicating the direction of the shock.

"As you will understand, this instrument did not record the violence or duration of the shock indicated by it. It is, therefore, more properly called a seismoscope than a seismometer. Another form of seismoscope consisted of a number of tall vessels filled with a thick, viscid liquid. On the shaking of these vessels by a passing earthquake wave, as they leaned in a direction dependent on that in which the shock reached them, some of the sticky liquid was washed against the sides, thus indicating the direction of the shock. In a latter form of this instrument, a column of mercury is employed in place of the sticky liquid, and small floats, consisting of iron, placed on the surface of the mercury. By attaching threads to these weights, and passing the free end of the thread over pulleys, it is possible to record the movements of the weights.

"In addition to the above instruments, there are others known as pendulum seismometers. Instruments of this class depend for their operation on the following principle: If a comparatively heavy weight, say in the form of an iron ring, be suspended by threads attached to an object rigidly connected with the earth, on the passage of an earthquake wave the earth will move under the ring before the movement is imparted to the iron ring. If, therefore, a pointer be rigidly fixed to the ring at one end, the other end being permitted to rest on a piece of smoked glass, which is also rigidly attached to the earth, the plate moves under the pointer, so that there will be traced on the surface of the smoked glass markings which will indicate the number, direction, and intensity of the shocks. Pendulum earthquake recorders are now very commonly employed. These latter instruments are generally provided with means whereby, on the passage of the earthquake wave, an electric circuit is closed, which, by means of

an electro-magnet moving a marker, records the exact time at which the shock occurs."

The boys were greatly interested in this lecture on earthquakes, not only on account of what it contained, but also by reason of the recent occurrence of the destructive San Francisco earthquake.

Bert was especially interested in the description of earthquake recorders or seismographs.

"Mr. Johnson," he inquired, "you say that no part of the earth is entirely free from earthquake shocks. Might we have an earthquake shock in this part of the world?"

"Oh, yes," said Mr. Johnson, "earthquake shocks have been noticed several times in the eastern part of the United States."

"Look at Bert," whispered Patsy to Heinrich. "Oi fancy Oi can see him smoiling to himself, as if it plazed him intoirely that we moight have an earthquake shock here."

"Dot iss so," whispered Heinrich. "I haf dot meinself seen."

Fred also noticed the apparent look of joy on Bert's face when he was assured that an earthquake in the neighborhood of the Mallory Academy was not an impossibility, and afterwards, on going home with him, said:

"Bert, would you be glad if an earthquake visited this place?"

"Of course I would," said Bert, and then immediately correcting himself, "that is, if no very great damage was done and nobody was killed. I say, Fred," he continued, "what do you say to our trying to make a seismograph? I think I have invented one which I will explain to you."

"That would be great!" said Fred. "I'll be glad to help you with it."

"All right," said Bert; "but don't mention the matter to any of the boys. I wish to put this instrument in the school building, but I shall, of course, ask Dr. Mallory. As there is no danger in this, I think the Doctor will let us try the experiment."

We shall not attempt to describe in detail

Bert's invention of the seismograph. It must suffice to say that it was constructed on the principle of the pendulum instrument, and was, moreover, provided with an attachment by means of which an electric bell was sounded whenever the movement of the point attached to the suspended ring closed an electric circuit. This bell was placed in a small room communicating directly with the general assembly room.

As might have been expected, the efforts of Bert and Fred to prevent their schoolmates from finding out what they were doing were unsuccessful. It soon was generally known to the boys, and they were obliged to take no little good-natured chaffing on the matter.

"I say, Bert," remarked one of the boys, "is there any danger in this wonderful invention being placed in the school building? You remember that the great volcanic eruption you showed us produced two very serious explosions."

"What do you mean?" asked Bert.

"Why, the blowing up of the stuff you had placed in the ground, and the subsequent blowing up that you and Fred received from the Doctor."

"No," said Bert, laughing, "this experiment is all right. The Doctor has given us permission to set up the apparatus in the school building and Mr. Johnson has given us some points as to making it."

When Patsy and Heinrich heard of the instrument that Bert and Fred were constructing, they put their heads together and planned a trick on Bert that was evolved mainly by the Irish lad.

One morning, after the instrument had been properly erected and tested, while the entire school was together in the assembly room, the door of the small room in which the electric bell was placed being open, they were all greatly startled by a sudden furious ringing of the seismograph bell. By this time there was not

a boy in the assembly that did not know that the bell was connected with the earthquake recorder.

Noticing that no trembling of the school building attended the ringing of the bell, the Doctor smiled, scenting some joke on the young inventors. He was convinced of this as the bell again and again fiercely sounded.

"Bridges," he said, "you and Brown had better go and see if you can find out what is the matter with your seismograph."

Bert and Fred left the room, and in a few minutes came back with a broad grin on their faces.

"Well," said the Doctor, "have you discovered the cause of the bell ringing?"

"Yes, sir," said Bert, smiling. "Some of the boys have played a very clever trick on us."

"Anyhow," said Fred, "it shows that the instrument was properly constructed, and if there had been an earthquake it would have worked all right."

Dr. Mallory did not belong to that class of

head masters who rigidly ruled harmless fun out of the schoolroom. He was pleased at the good-natured manner in which the two boys had taken the joke that had been played on them.

"Well, boys," he asked, "do you care to give your classmates the particulars of this joke, or would you rather prefer to keep it to yourselves?"

"Why, Doctor," exclaimed Bert, "I have no objection at all to telling all about it. Have you, Fred?"

"None whatever."

"Then," said Bert, "when we reached the room we found Mrs. Mallory's cat greatly enjoying itself eating a piece of meat that some one must have thrown in the room through the open transom. We do not know how the cat got there, but she was having a good time, and was complacently shaking her tail in delight. Every time the tail struck the iron ring of the seismograph, she moved it so that the electric circuit was closed by the coming together of the con-

tacts, as we could tell by the ringing of the electric bell."

There was a shout of laughter as Bert described the clever manner in which the joke had been played on them. This, however, was soon checked by Dr. Mallory, who said:

"Now, boys, you have all had your laugh, and we have lost a few minutes, which, however, we can readily make up." So he rang the bell dismissing the boys to their different classrooms.

Bert and Fred afterwards learned that the trick had been planned by Patsy and Heinrich, who had made repeated efforts to get into the room, Bert and Fred, fearing this, had always locked the door after them. Patsy, however, had thrown a piece of meat into the room, near the instrument, about the time the boys were going into the assembly room, and had afterwards introduced the cat through the same opening.

CHAPTER VIII

THE FETISH

THERE was among the servants of the Mallory Academy, a very old negro named Sambo. No one in the Academy knew just how old he was. Dr. Mallory said that years before, when the man first came into his father's family as a servant, he was an old-looking man. Sambo himself claimed that he had been captured by slavers and carried from his home in the southern part of Africa long before the Emancipation Proclamation of Lincoln had freed all the blacks in America.

If, as is generally understood, the name Sambo is correctly given only to a mulatto or half black, then the man's name was incorrectly applied, for Sambo was as black as the ace of spades.

By reason of his age, Sambo was unable to do much work. The Doctor, however, had provided him with a room in the basement of the Academy building, where he lived very comfortably. Like many of the people of his race, he was a born cook, and was permitted by the Doctor to prepare various wholesome sweets, especially sugar-candy, in which the boys invested no little of their spare cash. The small profits the old man made in this manner enabled him to purchase tobacco, and to lay by, as he used to say, much to the amusement of the boys, "some money for his old age." For Sambo was something of a miser.

Sambo claimed that his father had been a great man in southern Africa. As well as the boys could make out, his father was what is called a "medicine man," or one believed to be able to cast charms and spells on people, causing disasters to fall on whoever they choose. He said his father had taught him something of this power. He believed in ghosts and spirits,

and especially in devils, and was always in great dread lest some one would cast spells on him.

Bert and Fred were one day sitting in the old man's room waiting for a batch of sugar-candy they had ordered. Sambo had been telling them how the slavers had captured him, when he was much younger than either of them.

"In what part of Africa did your people live, Sambo?" asked Bert.

"Dis chile's people come from de mountings in South Afriky; close to de diamond mines. My fader big man in Afriky; yah, yah, berry big man. He cast charms on his enemies, made de springs dry up; hurt his enemies by keepin' de rain from fallin' till everyt'ing would die for want of water. Yah, fader berry big man, magic man."

"Sambo," said Fred, "did you learn anything about magic from your father?".

"Iss, dis darky learnt some magic, not much, cause slavers took him away when berry young."

"Can you raise ghosts or cast spells on people?" asked Bert.

"Iss, dis chile can cast spells. Yah, I hab a fetish," he said, taking out of his pocket a small package that was wrapped in a piece of rough leather. "I put dis fetish in a man's pocket, and de debil inside come out and bites him."

"Oh, come, Sambo," said Bert, incredulously. "You can't fool us. If this thing you call a fetish could bite a man when it was placed in his pocket, why don't it bite you; for you carry it in your pocket, don't you?"

"Yah," said Sambo, "dat's *magic*. Dis chile knows how to work the spell," opening his eyes wider and wider as he spoke as if he was proud of the occult powers he claimed the fetish possessed.

"Fred," said Bert, "do you know what Sambo means by the word fetish?"

"Yes," said Fred. "I remember reading something about fetishes some time ago. A fetish is a kind of a talisman or magic object

that is believed to possess certain charms, by reason of its power over some supernatural being. The one who owns a fetish is believed to be able to make this being work his will."

"Yah, yah," said Sambo, who had been listening to Fred's description. "Dis chile hab a great fetish. Can cast spell on people by putting the fetish in their pocket; fetish bites man, but man don't feel the bite right away. Not till one, two, three weeks afterwards. Den he forgets all about de fetish dat was in his pocket."

"Now, Sambo," said Bert, "I don't believe that is possible. How long have you been carrying this in your pocket?"

"Dis chile hab him eber since he come from Afriky. He neber lose him. When dis chile don' like man, he slips de fetish in his pocket, and de debil bites him and makes him squeak."

"But why don't it bite you?" asked Fred.

"Sambo knows how to keep de fetish's mouth shut."

"Come, Sambo," said both boys, "show us how you do it."

"No, dis chile keep him secret. If dis chile tell you too much, de debil in de fetish might get mad, and bite Sambo."

"But, Sambo," replied Fred, "you don't mind our only looking at this fetish, do you? That won't hurt anything."

"No, Sambo don't mind your jist lookin' at it," said the darky, and with that he handed Bert the bag he had taken from his pocket.

"May I take it out of the leather case?" asked Bert.

"Iss, Sambo let you take him out," the old negro said as if conferring a great favor.

Bert did so and was surprised to find that the bag contained something closely wrapped in several pieces of thin sheet lead, such as are employed for lining tea boxes.

"Ah," he cried, "Sambo, now I know you are fooling us. This is only sheet lead. I know lead does not possess the power of bit-

ing or burning anybody when brought near them."

"Iss," said Sambo, "but you only see de outside. Dere is something inside de lead dat can bite."

"Well, then, Sambo, show us what is inside the lead."

"No, Sambo is afraid to take off de lead. Dere is a debil inside. If Sambo takes off de cover, de debil would come out and bite Sambo, maybe."

"But show us, Sambo," said Bert, "what you do with this fetish when you place it in the pocket of the person you wish it to bite."

"Iss," said Sambo, "I will show you, Massa Bert. I likes you. You neber speak cross to old Sambo, but always look right in his face with smiling eyes. I will show you. See," he said, "I only open de end a little, and let de debil inside put out his head and bite de person;" saying this, Sambo unwrapped a small portion of the lead covering. Bert and Fred

curiously looked through the open end, but all they could see was a lump of a dark looking mineral substance.

"What do you suppose it is, Fred?" asked Bert. "I do not remember every seeing any mineral substance that looked like this, do you?"

"I don't know, but I suspect that what Sambo has brought with him from Africa, as a fetish, is a specimen of a rare substance that I remember reading about in several of my books on chemistry."

"What is this substance called?" asked Bert, greatly interested.

"It is a mineral containing a very rare substance called radium."

"Oh," said Bert. "I, too, remember reading about radium. It possesses the curious power of throwing off exceedingly small fragments that are able to penetrate and greatly heat many solid bodies."

"Yes," replied Fred, "I guess that is the explanation of Sambo's fetish. If the black

mineral inside the sheet-lead covering contains radium, or, indeed, any substance like radium, for there are other substances that possess the same power, then what Sambo says about it burning people would be all right, for the exceedingly small fragments, or, as they are generally called, the radium rays, are thrown off with such a velocity that they can readily pass through many solid substances, such as glass, stone, etc. They cannot, however, pass through such metals as lead or iron. When the rays fall on the human body, they not only readily pass through the clothing, but enter the flesh and produce serious burns. What is strange about these burns is that the inflammation is often not set up until for as many as several weeks afterwards. If then, Sambo's fetish contains radium or some similar substance, I can readily understand that it could do just what he claims for it."

"Is there any way by which we can see if you are right?" asked Bert.

"Yes," answered Fred. "I have some very

sensitive photographic dry-plates in the chemical laboratory. If we take one of these plates into the dark photographic room, and carefully wrap it up in a number of layers of black paper, so that we can safely bring it into the light, and then place the photographic plate with its sensitive side up in such a position as to be near the open ends of Sambo's fetish, the exceedingly small fragments thrown off from the radium, if such be present, would readily penetrate the blackened paper, and act on the sensitive plate. In order that we may see whether this action has taken place, we will place some small metallic objects like pins, needles, pens, penknives or pieces of iron on top of the plate. Then when the radium rays come out of the fetish, they will act on the unprotected parts of the plate, and produce chemical changes in these parts, but will be unable to pass through the pieces of iron."

"That will be a splendid experiment, Fred," said Bert, excitedly. "Let's try it."

The difficulty was to obtain Sambo's permis-

sion. After considerable coaxing, however, he agreed that if it could be done without removing the fetish from his room, they might do what they asked. So, preparing the photographic plate as above described, and placing various metallic objects on its surface, they placed it on a shelf in Sambo's room with the open fetish immediately above it. This was done on Thursday afternoon. At the close of the school on the following Monday afternoon, the boys took the plate, and, followed by Sambo, who, his curiosity being greatly aroused, begged permission to be present, entered the dark room of the Academy.

Unwrapping the plate and placing it face upwards in the shallow dish employed for developing, Fred prepared the developing solution and poured it over the surface of the plate. In a very little while the developing commenced to act, showing that the plate had been acted on wherever it had not been covered by the articles of iron.

"See," said Sambo, greatly excited, "de debil in de fetish bit de glass, but couldn't get through in dese places," pointing to where the pieces of iron and lead had been lying.

The boys told Mr. Johnson of the discovery they had made, and he informed Dr. Mallory, who was very proud that two boys of his Academy had made such a valuable discovery. Sambo was also greatly pleased when Dr. Mallory requested him, as a special favor, to permit a number of additional experiments to be made in the exposure of photographic plates, etc., with the so-called fetish. The discovery was not limited to the Academy, for some scientific men hearing of it, came to investigate the matter and prepared a paper on the curious discovery of radium in a South African fetish.

As was natural, both Fred and Bert began reading what books they could find that treated of the subject of radio-activity.

There were many things in these books that were beyond their comprehension, but by hard

work, together with occasional help from Mr. Johnson, they managed to get fairly good ideas of this curious kind of matter.

As a result of their reading, together with what Mr. Johnson told them, they learned the following facts concerning radio-activity. As early as 1896, a French physicist, named Becquerel, made the interesting discovery that compounds of uranium possess the power of giving off a radiation that was able to penetrate substances opaque to ordinary light, as well as to affect photographic plates in a manner similar to light. These rays are sometimes called either the Becquerel rays, from the name of their discoverer, or uranium rays after their source. It was subsequently discovered that thorium and its compounds possessed similar properties, while still later a discovery showed that the mineral substance known as pitchblende, the principal source from which uranium is obtained, contains two elementary substances, previously unknown, *i. e.,* polonium and radium, that are at least

one hundred thousand times more powerful in emitting Becquerel rays than uranium. The general name of radio-active substances has been given to uranium, polonium and radium. These substances possess the following properties:

1. They give off rays that can readily penetrate substances opaque to ordinary light.

2. They are capable of affecting a photographic plate in a manner similar to that of light.

3. They possess the power of emitting phosphorescent and flourescent light.

4. They appear to be able to give off, continuously and spontaneously, energy at a constant rate, without, as far as is now known, requiring the immediate action of any external cause.

It troubled both Bert and Fred no little to understand how it was possible for any substance continuously to give off energy unless its store of energy was replenished. They were

sufficiently posted in natural philosophy to know that in accordance with the doctrine of the conservation of energy, all bodies possessed a definite amount of energy, so that if a radioactive substance was constantly throwing off energy, its total stock of energy must necessarily decrease, so they asked Mr. Johnson to explain how such a state of affairs was possible.

"That is a question," replied Mr. Johnson, "which has troubled scientific men no little. It was at first believed that this fact would necessitate the abandonment of the doctrine of the conservation of energy. It is now understood, however, that while this is not necessary, yet a most radical change must be made in the old atomic theory of matter. This will interest you especially, Fred," he said, turning to the lad, "since I know how fond you are of chemistry. The old ideas of the chemical atom have been completely changed by the phenomena of radioactivity. It is no longer believed that the so-called chemical atoms of matter are indivisible

and inalterable. On the contrary, they are now believed to consist of a great number of exceedingly small particles, so small, indeed, that the almost innumerable particles that constitute an atom are not unlike the members of a miniature planetary system which revolve in orbits that are limited to the exceedingly small space occupied by the atom. These particles are of two distinct kinds: particles charged with negative electricity, which are quite small, having a mass of only about one one-thousandth that of a hydrogen atom; and particles charged with positive electricity that are about a thousand times larger than the negative particles.

"The energy given out by a radio-active substance does not at all differ from that given out by other substances. The energy thus thrown off is now believed to be only the energy originally charged on the substance. In the case of radio-active substances, however, the amount of this energy is so much greater than what was originally believed to have been possible, that

so long a time would be required to make the loss of energy readily appreciable, that it seems as though the radio-active substance is capable of giving off energy forever."

Fred was much astonished to learn that the atoms of matters which he had been taught to regard as absolutely indivisible, or in other words, that they could not be cut into smaller fragments, were now regarded as being composed of many thousands of smaller particles that were in ceaseless and active motion within the exceedingly small space occupied by each atom.

"Why, Mr. Johnson," he said, "if this theory be true, then the search of the alchemist for the philosopher's stone, whereby the baser metals can be changed into gold, should be possible; for, if the atoms of gold consist of combinations of still smaller atoms of matter, it would only be necessary to put these ingredients together so as to produce gold. Is not this true?"

"Yes, Brown," replied Mr. Johnson, "you are quite correct. If this theory be true, then it should be possible to form different elementary substances such as gold, and, indeed, some elementary substances have already been produced in this way."

After the success of their photographic printing, Bert had several long talks with Sambo, from whom he obtained as good an idea as he could of the particular part of Africa in which he formerly lived, and from which he believed his father got the fetish. What particularly interested him was the statement made by Sambo that nearly all the medicine men and magicians in that part of the country had fetishes of this character, and that his father had one which was much more powerful than the one the boys had seen.

Bert said to Fred one day:

"If what Sambo tells me is true, there must be in this part of Africa a large deposit of radium minerals. Now, I remember reading in

the newspapers that a pound of radium was worth at least two and three-quarter millions of dollars. It would, therefore, pay to find the location of this deposit if it exists. But, of course, this high price per pound is based on the very small amount of radium that has thus far been produced, the world's total supply at the present time being probably but a very small fraction of a pound."

One day when the boys were sitting together in the playground eating their lunch, Bert said to Fred:

"I have just been reading of a curious theory of volcanoes."

"Let's have it."

"What would you say, Fred, to volcanoes being caused by the presence of radio-active materials in the earth?"

"Why," said Fred, after thinking for a moment, "I would say that would be an exceedingly odd thory. Tell me about it, please."

"This theory," replied Bert, "states that vol-

canoes are caused by the presence of radio-active minerals in the earth. The theory assumes that the part of the crust from which the molten material escapes is much nearer the surface than has heretofore been believed. That, instead of being twenty-eight or thirty miles below the surface, it is probably only from one to two and a half miles."

"But how can the presence of radium in the earth's crust several miles below the surface cause volcanic action?" asked Fred.

"As I understand it, the exceedingly small particles shot off from a radio-active substance raise the temperature of most solid substances against which they strike, so that if sufficient time is given these substances may be heated to the fusing point. It has been shown, for example, that the energy given off by a small quantity of radium during a single day is sufficient to melt a mass of ice many times its own weight. If, therefore, fairly large quantities of such substances exist in the crust of the earth,

limited portions may be gradually raised to the fusing point."

"But,' said Fred, "it seems to me that if radium or other similar substances exist in the earth in such quantities as to fuse portions of the crust, traces of radium ought to be found either in the soil, or in the air near the soil, and if volcanoes are so caused in this manner, radium ought to be found in the gases and vapors that escape from the craters of the volcanoes."

"I think that's right. Indeed, I understand that a peculiar emanation due to radium is always found in the soil or in the air near the earth, and that, moreover, the amount of this always increases with the increase in depth. Air drawn through a tube sunk in the earth, is found to contain a greater quantity of radium than that taken from near the surface. In the same way, the air in cellars or caves contains more of this emanation than does the open atmosphere.

"But what is still more interesting, this emana-

tion or gas is soluble in water, and is generally present in the waters of deep-seated springs, especially in the case of hot springs. It is claimed that the waters of some hot springs in Italy and the United States contain appreciable quantities of radium."

Of course, Bert and Fred spoke to Mr. Johnson about the theory. He had already read the paper and thought it very clever. He was not, however, ready to believe that volcanoes were due to the action of radio-active materials, since he did not think the presence of sufficient materials of this character in the crust had as yet been proved.

CHAPTER IX

A PLEASANT WALK

THE school year at the Academy was now drawing to a close, and the summer holidays rapidly approaching. One afternoon, when the class in geology had just finished a recitation on the "weathering" of rocks, Bert and Fred had remained behind in order to ask Mr. Johnson some questions on what they had been studying.

"Weathering is going on around us every day," said Mr. Johnson. "You could understand this action much better by seeing it for yourselves. How would you like, say next Saturday, to take a walk with me when we can see some of the actions described as 'weathering' actually at work?"

"That will be jolly!" said the boys. "Do you mean the whole of Saturday, or only a part of the day?"

"Whichever you choose. It would, however, be pleasanter to take our lunch with us, and be away the entire day. Then we shall not be hurried, can go further, and see more. Shall I invite O'Connor and Schmidt to go with us, or would you prefer there being only three in the party?"

"I think it would be more pleasant if both of them were invited. Don't you, Fred?"

"Yes, I say let them come along. They will have fun and we shall enjoy having them."

They arranged to meet at any early hour at the Academy. A heavy rain began to fall Friday afternoon, and continued late into the night, so that the boys began to fear that it would be necessary to postpone the excursion.

"It will be all right," said Mr. Johnson, when they questioned him, "if it clears during the night; for the roads will dry up rapidly, and the

air, instead of being sultry, as it is to-day, will probably be more pleasant."

Fortunately, the weather did clear during the early morning, so that Saturday was just the day to make a long walk pleasant, the air being both cooler and dryer than it often is during the latter part of June in Eastern Pennsylvania. By half-past seven the boys were at the Academy, where they found Mr. Johnson waiting for them. Patsy and Heinrich had not yet put in an appearance, but in a few minutes were seen coming up the road. Heinrich was armed with a net for catching butterflies, for he was much interested in the study of insects, of which he already had a good collection.

"I bring my net," he said, "so dat I my collection of butterflies can make larger."

"That is right, Schmidt," said Mr. Johnson. "I think it more than likely that you will have a chance of obtaining many specimens to-day. And what have you brought with you, O'Connor?" he asked, turning to the Irish lad.

"Faith, Oi have brought Patsy O'Connor, with a full stomach and a somewhat empty head, but Oi be thinking that if things turn out as Oi expect, Oi will be going home with a full head and an empty stomach."

"I should not be surprised if that were so," said Mr. Johnson, laughing. "Now, boys, we have a splendid day for a tramp, and plenty of time before us. I know there will be much to see, and, therefore, I hope there will be no trouble in doing what O'Connor suggested as to increasing our knowledge. Just how much we shall be able to learn depends on how closely we observe all there is to be seen. I think it well to keep in mind some definite direction in which we intend to make observations. I, therefore, propose, before starting, that we agree on some particular class of geological phenomena we will study especially to-day. Of course, I do not mean that we will refuse to observe other things of interest that may come before us. On the contrary, we will take an interest in every-

thing, but, nevertheless, I think it will be well if we agree to make our principal observations along certain lines."

"A good idea," said Fred. "What shall we especially observe to-day, Mr. Johnson?"

"Suppose we limit our observations to the changes of level that are slowly taking place in the height of the land above the general level of the sea. As you have already learned, the gradual cooling of the interior causes a warping of the crust that increases the height of the land in some places, and decreases its height in other places. Now, I want to ask you a question. Suppose the earth had entirely cooled, and that no warping could possibly take place, would the elevation of the land continue as it is to-day, or are there forces at work that would gradually break down the mountains and other elevations and bring them to near the level of the sea?"

This question greatly interested the boys. It had never been put to them in such a plain manner. After a little thought, Bert said:

"I am not certain, Mr. Johnson, but I think there are forces that are slowly breaking down portions of the higher lands; but whether such forces would be able, even during a long time, to cut down the mountains and the hills and throw them into the sea, I do not know. It hardly appears, however, to be probable."

"Well, then," said Mr. Johnson, "listen to me. Forces are constantly acting on the land-masses of the earth that are slowly but surely breaking the mountains and other highlands into small fragments and carrying them to the ocean. Now, I propose that during our walk to-day we shall look especially for these movements of the land toward the sea. Whenever you believe that you see any such evidences, call attention to them, so that we all can observe them, and determine whether or not we agree with you."

"Dot vill be very interesting," said Heinrich, "that I can see the land toward the sea moving!"

"Yes," said Patsy, "it will be a great game of

'I spy,' played with mountains. Bedad, there, Mr. Mountain, I see you moving off toward the say. Stop that now for Oi have me eye on ye!"

The boys laughed at Patsy's curious idea of the character of the observations that they were to make during their walk. It seemed that neither Patsy nor Heinrich thoroughly comprehended what Mr. Johnson meant.

"Of course, boys," said Mr. Johnson, laughing, "these movements take place very slowly, so that unless you are careful, you will not see them. However, we will let that pass for the moment. You will understand the matter better after we have met with a few instances of movements of this character."

After a brisk walk of about three-quarters of an hour, they came to the Schuylkill River. The heavy rain of the preceding night had caused the river to rise considerably in its channel, so that a large quantity of very muddy water was being carried rapidly down stream. Bert, who had been thinking over the problem that Mr.

... looked for a moment ... that was rapidly making ... said:

... of land moving ...

... Bert!" said Patsy,

... said Bert, "isn't ... toward ...?"

... you're right ...," said Patsy. ... wasn't afther water ... down ... the say that we were ... afther ...

..., Patsy," said Bert, "don't you think ... is some land in the water?"

... ye say?" he exclaimed. Then, think- ... the idea came suddenly ... "Now, I under- ... the land has ... places above here, and ... water toward ... the bright lad

for obsarvin' things,'' he added, looking at Bert with sincere admiration. ''Now, Oi begin to see one of the ways in which the 'land is movin' toward the say.' ''

''You have pointed out a good instance,'' said Mr. Johnson to Bert.

As they were watching the swollen stream flowing rapidly toward its mouth, Bert remarked:

''It would not be difficult, would it, sir, to figure out just how much mineral matter the river is thus carrying away. If one were to take a vessel that holds a certain number of gallons, or cubic feet of water, fill it with this muddy water, and let it stand, until the mud settled, then dry the mud and weigh it, it would be easy to find the number of pounds of mineral matter in every gallon or cubic foot of water. Then, if we knew the rate at which the water is moving, we could tell exactly how much water the river was carrying down stream to the Delaware, by which river much of it would, of course, be

carried to the Atlantic Ocean. When one remembers the great number of large rivers in the world, it is easy to see that, all together, they must carry very large quantities of land toward the ocean."

"Yes," replied Mr. Johnson, "it is down the river valleys that practically all the mineral matters of the earth are being carried toward the sea. In large rivers the amount of matter thus thrown into the ocean is very great. Careful measurements made by engineers of the United States Government, show that the Mississippi River brings down every year an amount of mineral matter equal to 812,500,000,000,000 pounds. But you can never fully grasp the meaning of such figures, so I will put it another way. This great river brings down every year an amount of mineral matter, which, if spread over a field one square mile in area, would cover it to a depth of 241 feet. Besides this, of course, as you may see by looking at the muddy water in the Schuylkill, a considerable portion

of the mineral matter that is suspended in the water falls to the bottom before reaching the ocean, forming mud banks that tend to fill up the river channel. Now, as the river flows on, much of this material is gradually pushed toward the sea; or, perhaps, more correctly, is picked up and again carried down stream a certain distance, deposited, and again picked up, when a new flood increases the speed of the water, much of the matter, however, eventually reaching the ocean. The amount carried each year in this manner by the Mississippi would be sufficient, if spread over the area of the square mile already referred to, to make the height of the total deposit reach 268 feet. You can, therefore, easily see that if the enormous amount of mineral matter the Mississippi River carries down every year was carried down at any one time, it would correspond to the movement of almost a small mountain. Now, O'Connor," he said, laughing, "put that idea in your head to begin with."

"Sure, if I do sor," said Patsy, "Oi will have no more room for anything else."

"Fortunately, O'Connor," said Mr. Johnson, laughing, "the box on your shoulders called your head, is so marvelously fashioned that if you only put such ideas in it in the proper manner, instead of becoming full, it actually makes room for more. Calculations show that the amount of mineral matter the Mississippi River brings every year to the ocean would require its entire basin to be lowered, on an average, one foot in about every five thousand years. In some river basins, this cutting down of the basin goes on much more rapidly. In the Ganges River, in India, the amount of mineral matter brought down each year is such as necessitates the leveling of the basin of the river one foot in every eighteen hundred years.

"Now, boys, if you understand thoroughly what I have told you, we will go on with our ramble, and see if we can observe any places

where we can detect this material actually being carried from the land to the water."

As they were walking along the banks of the river, Bert said to Mr. Johnson:

"Besides the mineral substances in the shape of mud that we can see in river water, are there not also mineral matters that are dissolved in the water, but which we are unable to see?"

"I can answer that question," said Fred. "All river water contains various mineral substances dissolved in it. These substances consist of various compounds of lime, magnesia and soda."

"I, too," said Heinrich, proudly, "can tell you somedings dot I know are true. Mein frient, who runs a steam-boiler saw-mill, tells me dot much trouble comes from what he calls boiler scale dot collects in the boiler. I haf seen a tube taken from such a boiler. It vas nearly filled with mineral matter, alretty."

"Yes, boys," said Mr. Johnson, "you are both

right. Brown, the substances you name are very common in river water. Schmidt's example of the proof of the presence of such mineral ingredients in the ordinary water that is pumped into steam boilers is an excellent one. As the water in the boiler is changed by heat into steam, the mineral matters remain in the tubes as a scale that gives much trouble, since it not only greatly decreases the amount of water the tubes can hold, but also, being non-conducting, prevents the heat of the furnace fires passing through in order to raise the water to the boiling point."

"But is not the amount of mineral matter carried down in this manner by rivers very small?" asked Bert.

"On the contrary, it is much larger than you might suppose. Calculations show that the rivers of England and Wales each year throw into the Atlantic Ocean an amount of dissolved mineral substances that in order to supply them would require a decrease in the height of the

entire land area of one foot in every thirteen thousand years.

"Then," Mr. Johnson went on, "you understand that when the rain falls on the surface of the earth and sinks into the soil, it dissolves out and carries with it a fairly large portion of the mineral ingredients of the rocks. But let us go on and see if any of you can observe some places where the soil is actually being thrown into the water, so that we can understand how all this mud and material gets into the water."

At several places along the river where the rain had cut deep gullies in the banks, this mineral matter had either been carried directly to the river, or had collected in small mud banks at the foot of the gullies. This was especially so in several railroad cuts, where the sides of the cuts had not been protected by grass. In other instances, in hilly portions of the road, the running off of the rain water had cut deep gullies in the roadbed, and workmen were already engaged in repairing these places.

As they extended their walk, many other interesting evidences of this action of water presented themselves. In several freshly ploughed fields, where the land had a considerable slope, deep gullies had been cut from the top to the bottom of the slope.

"I must now, however," said Mr. Johnson, "explain something that requires too long a time to be readily seen. This we have fortunately already studied somewhat in the classroom. I refer to the manner in which the surface of hard rocks are cut down by what is called weathering. This cutting action is caused by exposure to heat, moisture and air, but especially to the alternate freezing and melting of the ice formed by the water that soaks into the soil, or the porous rocks, or that fills the cracks and crevices in impervious rocks. When this water freezes, it expands with considerable force, and so splits the rocks. In all these ways, but especially by the action of freezing water, the surfaces of the hardest rocks are split, cracked or broken into

fragments that are so small that they can be picked up and carried off with the water that drains off the surface. Besides this, there is the chemical action of the air, or a kind of rusting away or oxidation of certain substances in the rocks, rendering them more porous, and permitting the water the more readily to soak into them.

"The power of water to dissolve mineral matter rapidly increases with the temperature. As the rain water sinks into the earth in certain regions, it becomes highly heated, and thus acquires the power of more readily dissolving mineral matters. Sometimes, too, the heated water becomes charged with such chemical substances as carbonic acid gas, or sulphurous acid, thus assisting the water in dissolving the rocks.

"But there is still another way in which the hard rocky surfaces are cut down even to very great depths. The power of running water to carry away or transfer mineral matters is very much greater as its velocity increases. In this

manner, when the water runs rapidly enough, it is capable of carrying the mineral particles along with it, and when these particles consist of sharp bits of quartz, or other hard rocks, they act like small chisels, planes, augers or saws, thus cutting away the hardest rocks. This process is known as 'erosion.' There are many wonderful examples of erosion in different parts of the world. One of the most remarkable is the cañon of the Colorado River in the western part of the United States. Here, the stream has cut a passage through the hard limestones and granites that form its bed, until it is now flowing in an enormous gully or gorge that in some places is more than a mile below the general level of the land."

"It must have taken a long time to produce such a great amount of cutting," said Fred, thoughtfully.

"Yes, Brown, you are right, but then the time during which this action has been taking place is also very great. The extent of geological time,

as you know, is to be counted by millions of years."

Toward noon, they ate their lunch in a piece of woods near a spring of cold water. They rested here a while after eating, and then continued their ramble until about three o'clock in the afternoon, when they returned by another route, getting back about eight o'clock in the evening. They all declared the walk a grand success. Heinrich obtained several beautiful specimens of butterflies. All increased their fund of general information, and certainly O'Connor had brought back with him "an empty stomach," but, as he claimed, a head filled with many useful geological facts that it did not contain at the beginning of that long remembered walk.

CHAPTER X

CAMP MALLORY

ALTHOUGH we have made no further reference to the magnificent prize offered by Mr. Brown since the time of its announcement in the assembly room of the Academy, yet the boys had by no means forgotten it. On the contrary, each was doing his best thoroughly to understand and master the subjects assigned for class work, and this not only because of the desire of each to win the prize, but also because the excellent methods of teaching employed by Mr. Johnson had awakened in the boys an earnest desire to master the subjects for their own sake.

It had been arranged that the examination for determining the winner of the prize was to be

held near the close of the term. The examination was to be both oral and written, and was to be conducted not only by Mr. Johnson, but also by a well-known professor of geology from a neighboring city.

As the time for the examination drew nearer and nearer, the boys gave a larger and larger proportion of their time to the necessary preparation. Patsy and Heinrich were especially busy in this work. Patsy made such wonderful progress that poor Heinrich was unable to keep up with him. Though Patsy did his best to explain the difficult parts to his friend, and in so doing was rewarded by having them more clearly impressed on his own mind, as for his own work, he never seemed to have forgotten that memorable first recitation to Mr. Johnson, when, after reading the answer directly out of the text-book, he was unable to explain its meaning. Ever since that time he insisted on thoroughly understanding everything he studied, and, as he was naturally bright and quick, he

made a progress that not only surprised Mr. Johnson and his classmates, but especially himself. One day Heinrich had been complimenting him on his progress in studying and Patsy said:

"Bedad, Heinrich, and it is Patsy O'Connor that is more surprised than you are that he can get so much of this wonderful stuff in his thick head."

"Keep at it already," replied Heinrich. "It would greatly pleasure me for you to win."

"Arragh, then, Heinrich," replied Patsy, "that would be grate indeed, but it is not for Patsy O'Connor to win such a prize. There are too many boys in the class who can bate him intoirely."

About a week before the breaking up of the Academy for the summer holidays, Bert said to Fred:

"How do you expect to spend the summer? Have you made any plans?"

"I believe the folks intend going to the sea-

shore about the middle of July; but I have no plan before that time," answered Fred. "I suppose I shall stay around here, as usual."

"How would you like to go with me and a few friends to camp out?" Bert asked Fred.

"How would I like it?" Fred exclaimed, adding eagerly, "give me a chance and I will soon show you! How big a crowd will there be?"

"I think that a party of six in all will be about right," said Bert, "say Heinrich, Patsy, Jack Adamson, Charlie Steelton, you and I. That will make just one full tent."

"That would be jolly. How big a tent shall we need?"

"That would depend on how close we are willing to sleep. I have been finding out about these things. An ordinary hospital tent is about 14x18 feet. Of course, we all could pack in a smaller tent, say in one 12x14, but that, I think, would be too close for comfort."

"Camping will be great fun. Of course, we should have to do our own cooking?"

"Yes," said Bert, "and that will be part of the fun."

"Certainly, the cooking may not be just first class," Fred remarked, "but as we have to do the eating, there need not be any kicking."

Invitations were extended to the other boys. After some time all received permission to go to camp. They arranged to be away for about ten days, and figured that the cost, including transportation, the hiring of a tent and boat, the purchase of food, cook-stove and other little things would be from eight to ten dollars per boy. The parents of all except Patsy were pretty well off, so that this did not stand in the way. As for Patsy, he had made some money selling papers after school hours, so he was able to go along.

The boys extended an invitation to Mr. Johnson, which he was unable to accept, since he had agreed to attend an educational conference in one of the Eastern States, where he was to deliver an address.

The site selected for the camp was on the New Jersey coast, near the mouth of Toms River, not far from a place called Island Heights. It was an ideal place for a boys' camp, since the river here is over a mile wide, and is comparatively shallow, affording excellent boating, swimming, fishing, crabbing, and so on.

The six boys safely reached the camp ground one Friday, about noon. It was, however, late in the day when they had completed the setting up of their tent and getting all their boxes, trunks, food, and various utensils to the camping ground. They had concluded not to take cots with them, but to sleep on the floor of the tent, and therefore, built a wooden floor by placing boards on cross pieces of timber, thus insuring a dry floor. They took with them sleeping bags formed of stout muslin about two and one-half feet in width by six feet in length. On reaching the camp grounds, by filling these bags with dry straw, fairly good mattresses were formed, and these placed on the wooden flooring and covered

with rubber blankets and cotton sheets formed excellent beds. The mattresses were placed side by side along one of the shorter sides of the tent, a hospital tent fourteen by eighteen feet, which left a fairly large space at the ends of the beds for trunks and other things. Two sugar barrels, in which their canned goods had been packed, served, when turned upside down and covered with towels, as two fairly good tables.

A small iron cooking stove, intended for the burning of either coal or wood, was placed outside their tent, under a rough shed formed of some old lumber they bought for the purpose at Island Heights.

The place selected for the tent was in a piece of woods on a point of land known as Pumpkin Point. Good drinking water was obtainable from a small drive pump hired in the neighborhood.

The necessary preparations for getting everything ready may not seem to amount to much when read over hastily, but all these things re-

quired very hard work on the part of the boys. In the first place, there was considerable trouble in getting their things hauled from the railroad station to the camp. Then, getting lumber ready for the building of the floor of the tent, the construction of the rude shed, and a few seats near by, meant no little work. The putting up of the tent, however, was interesting to the boys, and was not very severe work, it only being necessary to sink two tent poles in the ground at the proper distance apart, and to place on them the ridge-pole, which was provided with means for fixing it tightly to the uprights. The canvas, placed over the ridge-pole so that the top of the tent corresponded with the ridge-pole, was fixed in place by means of guy ropes, held near to the ground by wooden pegs provided with a notch in one side. These were driven firmly into the ground by a wooden mallet after the rope was placed in position. Immediately below the part of the tent to which the upper ends of the guy ropes were attached, flaps ex-

tended vertically downwards to the ground, forming the sides. The lower parts of these sides were then firmly attached to the ground by loops of rope slipped into the notches of pegs, driven into the ground, the method of attachment being like that employed for the lower ends of the guy ropes.

The canvas forming the front and rear of the tent was divided into halves by a vertical slit extending directly from the ridge to the ground, thus forming flaps, permitting the tent to be closed when desired; or, when the two flaps were folded back, opening the entire end. As a rule the back of the tent was kept closed.

An additional piece of canvas, called a "fly" was supported on an additional ridge pole resting on the front pole, and on another pole erected in the direct line of the two poles. This fly was not provided with sides like the rest of the tent, but was held firmly against the tip of the extended ridge pole by means of guy lines, thus providing an agreeable shade at the front

of the tent, but completely open at the sides and front.

Getting everything ready took so much time that it was after eight o'clock when all the work was completed. There had been no cooking, since the boys were too busy with their work. Indeed, no cooking was necessary, as they had brought enough cooked food with them from the city. As they sat in front of their tent by the side of a small fire they had built, talking about the things they intended to do while in camp, Bert said:

"Boys, we should agree on rules for the running of the camp. Don't you think so? Otherwise, things will not go smoothly and we shall not have any fun. I think it would be well to elect a Captain or Leader, to look after things generally, whom we will all agree to obey."

The boys, who knew that this was the usual practice in camping parties, agreed, so an election was held for Captain. When the ballots were all counted, they stood five for Bridges,

and one for Brown. In other words, five of the boys had voted for Bert, who himself had voted for Fred.

"Well, boys," said Bert, "I would rather you had elected some other boy, but since you wish it, I am willing to serve. Remember, however, that I will only act as Captain as long as you obey me. As soon as any boy refuses to obey, then you will have to elect some one else."

Bert spoke so seriously that the boys at once saw that they had made no mistake in the selection of their Captain.

"Now, boys," said Fred, "let's agree on the name for the camp."

This resulted after a little talk in the unanimous selection of the name of "Camp Mallory," for they were all fond both of the name of their school and its head.

"Captain Bridges," said one of the boys, laughing, "let us have our first orders."

"Well," said Bert, after a minute's reflection, "there are six of us. We have to do our

own cooking, and will take turns at this work. Would you rather a new boy should cook each meal, or that the same boy should be on duty for a whole day?"

After thinking the matter over, the boys concluded that it would be easier if each boy prepared the meals for an entire day, since his turn for the work would only come, at most, once more while in camp, and he might even escape that, as the cooks for the last four days were to be determined by drawing lots.

"Then," said Bert, writing some names on a slip of paper, "here is the first order," and he tacked the paper to the side of the front tent pole. It read as follows:

"Chefs for Camp Mallory.

"Saturday, Brown.

"Sunday, Bridges.

"Monday, Steelton.

"Tuesday, Schmidt.

"Wednesday, O'Connor.

"Thursday, Adamson.

"The assignments for the remaining days at camp will be determined by lot, and announced in due time before next Thursday.

"Bert Bridges,

"Captain."

"Now, we must have regular hours for meals," continued Bert, "and, of course, where-ever possible, every boy must be here on time. Heinrich will sound a bugle-call ten minutes before meals, so that if you are any distance from camp you will be able to get here on time. There is another matter," he continued, "that I wish to talk about. This afternoon, when we were all in swimming I was glad to see that every boy could swim well except Patsy. Now, we shall be on the water much of the time, for you know we have hired a boat, and Patsy must learn to swim as soon as possible, for in a boat on a big river like this, there is always a risk, not only to the boy himself, but even more so to those that are with him, if there is one of the boys who cannot swim."

"Bedad, it's Oi who wants to learn to schwim!" said Patsy. "But Oi don't want you to thry any thricks on me, for at the best Oi don't love the water over-much."

The truth was that Patsy was afraid the boys would duck him. Bert, who suspected this, said:

"Patsy, I will teach you how to swim and I will promise this: That, until you can swim, I shall never let your head go under water."

"Faith, if you promise me that, Bert, I know that you will keep your wor-rd intoirely, and Patsy O'Connor will soon be swimming around loike a duck."

"All right, Patsy," said Bert, "I will give you your first lesson to-morrow morning before breakfast. If you are not afraid and will agree to do exactly as I say, I promise that you will be able to swim a little before the end of the day."

"Faith, and it's a proud boy that Patsy O'Connor will be on the day he can swim," he said, wagging his head. "And I agree to the terms."

Bert saw that the boys were amused at the old-fashioned manner in which he was talking to them as to what should be done in camp, and were beginning to laugh. Indeed, one commenced to chaff him, saying:

"You are growing old suddenly, Captain. If I should shut my eyes, not knowing who was talking, I might think it was your grandfather's ghost."

"Yes," said Bert, laughing, "I suppose it does sound a little that way, but you have placed a great responsibility on me, and I must ask you to help me all you can to carry things on so as to make it both pleasant and safe for all."

It was now about half-past nine o'clock, and the hard work in getting the camp ready had made them tired and sleepy.

"Let's turn in," said Fred.

"I am ready," said Bert, and he then added quickly: "Boys, I am in the habit of reading a chapter in the Bible before going to bed, as probably most of you are. What do you say if

I read out loud to you the chapter I intended to read to myself?"

The proposition met with favor from all, so Bert began reading a selection from the eighth Psalm of David. The night had now fallen, and the heavens appeared dotted with bright stars. The boys sat where they could see the broad expanse of the river, which at this point, is more than a mile wide. The air was still, and the waters quiet, so that the surface of the river, like a huge mirror, reflected the images of the stars.

Bert began to read the third and fourth verses:

"'When I consider thy heavens, the works of thy fingers; the moon and the stars, which thou hast ordained; what is man that thou are mindful of him, or the son of man that thou hast visited him?'"

The boys felt the meaning of the great Psalmist more thoroughly than ever before.

When Bert had finished reading, without say-

ing anything, he knelt down. All the boys, some of whom had been wondering whether or not they would say their prayers before the others, immediately followed his example.

It did not take long for the boys to get into their pajamas, but when they laid down on their mattresses, sleeping was quite another thing. The spirit of fun, so natural to healthy boys, quickly showed itself, and many were the pranks and tricks they played on one another. Bert had placed his mattress on the floor nearest to the flap used for the door, with Fred next to him, Patsy had placed his in the far end of the tent. In the scrimmage that followed the relative places of the boys was not infrequently changed. At one time, Bert found Patsy occupying the place next to him.

"Hello, Patsy," he said, "where did you come from? I thought your place was at the other end of the tent?"

"Faith, so it was," said Patsy, "I guess it must have been a boyquake that brought me

here, for as you know," he said laughing, "earthquakes come especially at night!"

"Yes," said Bert, "and I guess that it was not the contraction of the cooling crust, but of the muscles of some of the boys that caused the convulsion. Let me show you what I mean."

But Patsy, knowing what was coming, instantly started rolling over the boys between him and his mattress, and soon had reached his own place.

"Look out, Patsy!" cried one of the boys. "What do you take me for? Do you think I am a macadamized road, that you roll over me that way?"

"Faith!" said Patsy, "I belave ye are. I know ye are a son of Adam, but I didn't know his first name was Mack."

After having kept up this monkeying for more than a half hour, they finally fell asleep, and quiet reigned in the tent.

Bert got up at five o'clock the next morning. The sun had been up for nearly half an hour.

Quietly waking Patsy, he said softly, "Come, Patsy, get up! I am ready to give you your first lesson in swimming. Don't make any noise, unless you want the other fellows looking on, and making fun of you."

"Faith," said Patsy, in a low tone, "I am thinking that the wather will be cold."

"Oh, come, don't be a baby! Do you want to learn to swim or not?"

Thus urged, Patsy promptly got up. The two boys threw off their clothes, and were soon in the water, since the river was only a short distance from their tent. Patsy hesitated for a few minutes to go in, but Bert said:

"Don't be so slow. Jump in quickly. You will soon feel warm."

Patsy did so, and after the first plunge was surprised to see how warm the water felt. He was delighted with that first lesson in swimming. Bert was an excellent swimmer, and what is rarer, a good teacher. As soon as Patsy was willing firmly to believe, by actual experience,

that no matter what happened, Bert would keep his head from going under water, all fear left him, and he was able to give his entire attention to Bert's instructions. Consequently, before he came out of the water, he could swim fairly well two or three strokes with the breast movement, and some eight or ten strokes turned on his back.

"It's Patsy O'Connor that's a proud and happy boy this day!" he said, enthusiastically. "It's a great tacher ye are, Captain Bert! I would niver have belaved I could learn so much in one lesson. I suppose that you will give me another lesson this day."

"Oh, yes; when the water is as warm as it is now there is no danger in taking two or three swims a day, provided one doesn't stay in too long," Bert answered.

By this time the noise made by Bert and Patsy over the swimming lesson had awakened the other boys, who joined them in the water. Patsy was greatly excited and asked each of the boys

to see the wonderful progress that he had made in the art of swimming.

This morning began Fred's day for cooking, and Bert insisted on helping him. Fred made out very well on his first trial, which was probably due, as Bert asserted, to the fact that Fred's study of chemistry taught him so much about boiling and heating things that he naturally took to the cooking of food. The first breakfast, consisting of coffee, and ham and eggs, was a great success. Indeed, either because the cooking was so good, or the appetites of the boys so great, the commissary department (of which, of course, Fred, being the cook, was the temporary head) found that a great mistake had been made in the purchasing of what was believed to be sufficient for an entire day. Before breakfast was over everything eatable that he had prepared, together with the bread and other stuff that he had bought for the rest of the day, had disappeared, while some of the hungry boys imitated Oliver Twist by asking for "more!"

"All right, boys," said Fred, "I haven't got your measure yet, but I promise that for dinner I will cook more than you can eat. I say, Captain," he said, turning to Bert, "you will have to send one of the boys to the village to get some stuff."

"That's right," said Patsy, "and whatever the Captain tells ye to buy, get a pound more av it, so that poor Jack Adamson shall not be starved intoirely."

The boys roared at this, for Adamson was a great eater. Jack blushed a little, and then acknowledged that he had a great appetite.

Since their site, as already stated, was not far from the village of Island Heights and its summer colony, they had no trouble in getting "the butcher, the baker, and the candle-stick maker" to call regularly to supply their daily wants. It was, however, far enough from the village to keep away visitors in the early morning hours, so that, as the camp grounds were surrounded by woods, the boys were able to go swimming

without bathing tights, thus making the bath much pleasanter.

After breakfast, some of the boys spent their time in the water, wading and crabbing, taking "a sun bath." During this time they had very little clothes on. Bert warned them, that unless they were more careful they would get a good dose of sunburn, but the reply of each boy was:

"Oh, I don't burn, I only tan!"

Each boy appeared determined to obtain as great a depth of tan as possible, anticipating the pleasure of showing it at home, and telling what a grand time he had at camp. This was especially the case with Adamson, Steelton, and Schmidt. Patsy was inclined to follow their example, but Bert said to him:

"Now, Patsy, if you want to learn to swim, you had better not stay too long in the sun, or you may be unable to take another lesson for several days."

Patsy's desire to learn to swim was so great that he followed this advice. It may be men-

tioned in advance that before the camp broke up, Patsy became an excellent swimmer.

Their first dinner, like the breakfast, was a success. The boys had brought Fred a bucketful of hardshell crabs, and he had prepared them by boiling them in an iron pot they had brought for the purpose. In the afternoon they all had a row of several hours on the river, visiting, among other places, the opposite shore, and going down the trestle bridge over which the railroad extends to Seaside Park. Fred, who was a good photographer, had brought his camera with him, and took a number of exposures, especially several instantaneous views of yachts, of which there were quite a number on the river belonging to the different cottagers. Still later in the afternoon, the boys visited a field attached to a neighboring farm, from which the grass had just been cut. Here they had a good game of baseball. There were a number of other boys' camps on different parts of Island Heights, so that there was no difficulty in getting up a good

game of ball with two full nines. The other team was a very strong nine that claimed that they had never yet been beaten, and that they doubted if any team Island Heights might raise could beat them. This, of course, resulted in a challenge game, and Tuesday afternoon was appointed. The three new boys who joined our six campers to make up a nine agreed to practice with them on Monday and Tuesday so that they could get accustomed to each other's play.

The next day being Sunday, the boys remained comparatively quiet. In the morning, they walked over to the village and attended church at the great auditorium. In the afternoon, they lay around in hammocks, or in groups under the shade of the tent-fly. By noon of that day, the three boys who had exposed themselves needlessly to the sun on Saturday, and who had in the early morning commenced to feel the effects of it, were unable to wear their clothes, the skin being raised in big blisters. Some of the boys had brought cold cream with them, and this

somewhat allayed the pain. Bert, however, who had seen bad cases of sunburn, and, in fact, had himself when younger experienced the pain it causes, walked over to the village and got the druggist there to put up a mixture consisting of equal parts of linseed oil and lime water. This being applied to the blistered parts by a piece of absorbent cotton, gave great relief to the sufferers. They were all healthy boys, however, and by Tuesday, were ready to take part in the ball game.

Sunday night, after the boys had all turned in and were nearly asleep, a noise was heard as if rain was falling on the roof of the tent. Fred, who was sleeping alongside of Bert, remarked:

"Bert, it sounds as if it were raining."

"It certainly does, and yet the sky is clear," he said, as he cautiously opened the flap of the tent, which was near him. "There is some joke about this. See if Patsy is in the tent."

"No," said Fred, going over to Patsy's mattress. "I guess Patsy is the rainmaker.

Yes," he said, "not only is his bed empty, but he has opened the flap of the tent nearest him and gone out."

"Let's follow him quietly," said Bert, "and turn the joke on him."

And then, picking up a bucket of ice water, they went silently out at Patsy's end of the tent, and avoiding the guy ropes, they stole up to him without him hearing them, and saw him throwing handful after handful of sand on the part of the tent where Bert was supposed to be sleeping. When near enough, Bert threw the bucket of ice water over him.

"Hello, Patsy," he shouted as he flung the water. "Come in out of the wet! Don't you hear the rain falling?"

"Arragh, then, Captain Bert," said Patsy ruefully, "the joke is on me! I am afraid I will have to wake early in the morning if I want to thry a trick on you."

All the boys began chaffing Patsy as soon as they heard what had taken place.

"Ah, Patsy," they said, "did you think that the Captain is as easy as Mr. Smith was with your specimen of gold ore?"

"Faith and Oi did," said Patsy; "but Oi'll not think that same again."

"Come, Patsy," said Bert, "take off your pajamas and slip into your bed. You will catch cold if you keep those wet things on."

"Oi'll not catch any cold," said Patsy, "but since you have made me drink all the ice water, Oi'll first go to the pump and fill the bucket, for some of the boys may want it." So picking up the lump of ice, he good-naturedly went out with the bucket, and soon returned with the clean ice in a bucket of fresh water. He then removed his wet pajamas, hung them up to dry, and turned in.

The boys were constantly playing good-natured jokes on one another. As we have already said, Patsy slept in the far end of the tent, so that his place could be easily reached from the outside, by partially undoing the flap

at this end. One night, while Patsy was in a sound sleep, Charlie Steelton, wishing to play a joke on him, slipped out of the tent, and commenced covering Patsy with sand. Patsy took the joke good-naturedly, and Steelton, delighted at the thought of being able to thus play a trick on so sharp a boy as Patsy, determined to try the same trick again, with some variations. He had not, however, properly sized up the Irish boy, as he soon found out. The next night, Patsy had apparently fallen asleep very early, although he was the last to come into the tent. After carefully listening, Steelton, believing that he was fast asleep, stole out of the tent in his pajamas, having first quietly awakened the rest of the boys who were asleep except Patsy, so that they could enjoy the joke. He went outside the tent, and soon could be heard approaching Patsy's end. A suspicious chuckling and laughing, however, came from where Patsy was lying and Heinrich, who had also evidently been let in on the joke, appeared to

think something very funny was going to happen.

"Ach, dot iss splendid!" he said. "Dot iss a great idea, Patsy."

And now something happened to Steelton, who had evidently met with a surprise, for he was heard muttering:

"I wonder what this is, anyhow."

He next slipped over a rope that had evidently been placed there purposely, and commenced rolling. He had no sooner gotten up than another rope tripped him, and on the second tripping he evidently lost his temper, for he lay kicking and growling to himself.

"Let's light the lantern," said Bert, "and go see what is the matter with him."

The light of the lantern disclosed a most woful looking object. Patsy had invested a dime in a dozen sheets of fly paper, and had ingeniously spread them with the sticky sides up, around the place he was sure Steelton would visit that night.

He had, moreover, ingeniously arranged a number of ropes on which the boy would stumble. Patsy's plan had been so successful that not only were Steelton's bare feet covered with the sticky paper, but his pajamas, face, hair and hands and other parts of his body had likewise received their share. Indeed, he had succeeded in bagging the entire dozen sheets of fly paper Patsy had prepared for him.

"Oi was afraid," explained Patsy, "that ye might catch cold standing out there in your barefeet, so I spread some bits of paper carpet for ye to stand on!"

Although naturally angry, Steelton made the best of a bad bargain, and tried to take the joke good-naturedly. It was several hours before he was able to remove even the larger portion of the sticky material from his hands and feet. Indeed, the pieces that got in his hair left evidences of Patsy's kind attention even up to the time when he was ready to go home on the breaking up of camp.

The great match game of baseball, for Tuesday, came off at the time scheduled. The team against which the Mallory boys played was a good team, and Bert saw that the chances of his team getting left were great. Their opponents had a capital pitcher, who appeared to be able to deliver any kind of a ball. But Bert, who pitched for his team, was also as good a pitcher, so that at the end of the sixth inning, the score stood 0 to 0, thus showing not only good pitching, but good fielding on the part of both teams. At the beginning of the seventh inning, the pitcher on the opposite side was evidently done up and was replaced by another, and then the Mallory boys scored one run. Bert kept on pitching for his side. At the beginning of the ninth inning, the score was still 1 to 0, in favor of the Mallory boys. The other team was now at bat, and began to hit Bert's pitching, and after a while, with no one out, there were three on bases. Bert then showed his great judgment by a change in the pitchers;

for whispering something to Fred, he sent him in to pitch. Acting on Bert's whispered suggestion, Fred commenced to pitch what is known as a spit ball, in which the ball appears to come directly toward the batter without any whirling motion, thus having the appearance of a straight ball, but just as the batter hits at it, the ball drops, and to make the matter more difficult, the direction of the drop is very uncertain. In this manner, Fred struck out three boys in succession, and the Mallory team won the game. The game caused considerable excitement among the spectators who had come both from the village and from the cottages. Bert's team was given three hearty cheers. The Captain of the beaten team, who was a gentlemanly fellow, came up and shook Bert by the hand, saying:

"That was a fair beat." And then turning to Fred, he said: "I wish you would tell me how you deliver that kind of a ball."

"Oh," said Fred, laughing, "I guess I will have to talk that over with our Captain and the

boys of our team. I may however, show you before you leave.''

Before the opposing team left, Bert said to their Captain:

''May we not extend to you and your team an invitation to attend a camp fire on Thursday night at our camp? We will promise to give you a pleasant time.''

''I accept gladly,'' said the other Captain, gratefully, ''on the part of the boys. We'll be there, you may be sure.''

CHAPTER XI

THE CLAMBAKE

THERE are few things that bring out the peculiarities of people as well as camp life. This is especially the case in camps for boys. In the Mallory camp, during the first few days the boys felt the need of some place to put their clothes. A rope extended between the two tent poles could hold quite a number of things, but with six boys in the tent, it soon became too crowded to hold these articles satisfactorily, and was, moreover, apt to sag disagreeably in the middle. The two barrels already referred to, turned bottom upwards and covered with towels, served excellently as separate tables as far as they went, but something was especially needed on which such heavy articles as

coats, trousers, etc., could be hung. Here the ingenuity of Heinrich showed itself. On the Monday following their reaching camp he was seen in the woods cutting down a small fir tree.

"What are you going to do with that, Heinrich?" asked one of the boys.

"I make of him a hat-rack for holding clothes," replied Heinrich with a grin.

The boys laughed at the way Heinrich expressed himself.

"How will you do that?" he was asked.

"Vatch me," said Heinrich, "und I vill show you how I make him."

In the kind of tree Heinrich had selected, the branches were arranged around the main trunk inclined upwards, so that by simply removing some of them and trimming down those remaining, there resulted a contrivance which, when inserted in a hole in the floor of the tent, served admirably for the hanging of heavy articles. Indeed, this plan was so successful that Hein-

rich was persuaded to make two additional racks for the tent.

Fred, who was well posted in photography, had brought an excellent camera with him that took a five by seven plate. He employed very fast plates, so that he was able to take practically instantaneous views of the boys. In this manner, he succeeded in getting a number of excellent pictures of the boys in groups as well as individually. Some of these pictures were very comical. One especially was taken of the boys in their pajamas. He persuaded the boys to rub their eyes and yawn, as if they were very sleepy, and when he got them in the desired position he made the exposure. He named the picture:

"You have called me too early!"

Being anxious to see whether his exposures had been properly timed, Fred took some of his plates to the nearest photographer, where he had them developed, taking advantage of the dark room to reload his plate holders. He after-

wards had the good fortune to become acquainted with a gentleman occupying one of the summer cottages at Island Heights, who kindly offered him the use of his dark room for the development of his plates and for other work. In this manner, Fred was able to develop some of his comic exposures, and caused great fun in the camp by making blue prints of the same. Of course, as he explained to the boys, he intended to make silver prints when he returned to the city, where he could fix and tone them; for, in order to prevent them from gradually fading or being acted on by the atmosphere, it is necessary to subject it to a process called toning, which consists practically of covering the darkened surfaces of the silver with a thin layer of gold.

A cranberry bog in the neighborhood greatly interested the boys. The owner, finding that they were gentlemanly boys, not only invited them to visit the bog, but explained to them why it was necessary to flow water over it at times

in order to destroy insects that would otherwise eat up the plants. Heinrich was especially interested in this, and was able to give the owner some valuable information he had obtained from the books he had read on the subject of insect life. When some of the people in the village heard that the owner had invited the boys to visit him, they were surprised, since they were under the impression that the man was a cross-grained fellow who had little use for boys. As in many similar cases, however, the man was misunderstood, and he really had a kindly disposition when not rubbed the wrong way.

Fortunately for the boys, it was only during two days on which a change had taken place in the direction of the wind, that they experienced any annoyance from the mosquitoes that are sometimes so troublesome on the New Jersey coast. On these two days, however, great swarms of the pests suddenly appeared and bit them savagely, causing unpleasant itchings accompanied by marked swellings. Heinrich,

however, appeared very much pleased at the visit of the mosquitoes and was eager to explain to the boys the wonderful telescopic arrangement of their biting machines. He delighted in letting a mosquito light on his hand, pointing out the intelligent manner in which it would move from place to place until it came to a blood vessel, when it would immediately insert its blood-sucking device and begin feeding. It is needless to say that Heinrich was alone in admiration of these pests. The boys tried, but in vain, various liquids that had been recommended as being able to drive the pests away. Among these were tincture of pennyroyal and other odorous substances, that they rubbed over their hands and faces.

One evening, Patsy covered his face and hands with a substance that smelled so bad that the boys were unwilling to let him come near them, and which he had purchased from a druggist in the village for driving off the insects. But it seemed useless, and he remarked:

"Do you moind thot now! See the greedy little basts; how they sittle down on the dirthy shtuff Oi put on me hands and face! Bedad, they seem to like the same intoirely."

At night the boys tried the following plan: When they retired to their tents for the night, they tightly closed the flaps, and then, keeping the lantern lighted for a few moments, began a search for the insect intruders, who were summarily executed.

The camp fire, Thursday night, was a grand success. The Mallory boys and their invited guests sat around the fire telling stories and singing songs until late in the night. They were a jolly crowd, and had an especially jolly time. Their visiting friends were camping on the other side of the village nearer the mouth of the river. Fortunately, there were very few mosquitoes that night, and the visiting boys expressed their regret that they had not selected Pumpkin Point for their camp site. In relating their experiences, stories of the jokes they

"SAT AROUND THE FIRE TELLING STORIES"

had played on one another in the different camps were greatly relished. The visiting boys were especially delighted when they heard of Patsy's experience as a "rainmaker," and were particularly tickled to hear about the "fly paper carpet" he had prepared for Steelton. This latter joke, indeed, met with such appreciation that some few days afterwards, the boys heard that their visitors had tried it on some of the boys in their camp with pronounced success.

To the great delight of the boys, the gentleman who had permitted Fred to develop photographs at his home, and who had one of the most beautiful yachts on the river, handed him a note one day as he was leaving, asking if he would kindly read it to the boys at their supper table that night. When all the boys were assembled, Fred said:

"Boys, I have a short letter which I am going to ask the Captain to read to you."

Bert read the letter, which was as follows:

"'Mr. A. L. Bellground invites the boys of

Camp Mallory to spend Friday with him on his yacht, when he will endeavor to give them some fun in fishing, bathing, and a clambake. The yacht will start from the pier in front of his cottage at 8 A. M. It will be unnecessary to bring lunch, as that will be supplied by the yacht.' "

The invitation was received with a shout of delight from the boys.

"Well," said Bert, laughing, "am I to understand that you accept the invitation?"

"What are you giving us, Captain?" was the reply. "Such invitations don't come every day. Of course we accept it."

"Then," said Bert, "it won't be necessary to put the question. It is understood that you accept it."

"Yes, *sir,*" was the answer in a unanimous roar.

That day's experience on the yacht and at the clambake will never be forgotten by the boy guests. In the first place, they had splendid fish-

ing in the bay, catching nearly a hundred weakfish, some of which weighed at least a pound and a half. Then Mr. Bellground anchored in a part of the bay where there was a good sandy bottom, and the boys had a grand swim. After the bath, the yacht landed the party at a point from which they were able to reach the ocean beach, carrying the necessary articles with them. Here preparations were made for a regular clambake.

Mr. Bellground was a splendid host. He thoroughly understood boys, and knew just how to give them a good time. When they reached the coast, he said:

"Boys, I might readily have had the lunch prepared for you on the yacht, but I was sure you would enjoy yourselves more in camping out on the beach here, at a distance from the hotel or any of the cottages, and 'roughing it.' I have, therefore, arranged for a clambake, and have brought the necessary things with me, while I have ordered some fixings to be brought from

one of the hotels at Seaside Park. Now, I want your two best cooks to help me. Who are they?"

"Brown and Bridges," said the boys unanimously.

"You seem to agree on them. Well, Brown and Bridges, let us get to work! While we are getting things ready, I would like some of the boys to dig two bucketfuls of clams and others to bring me two or three bucketfuls of seaweed."

Mr. Bellground then selected a good-sized flat-topped stone that was sticking up a little distance above the sand. With the help of the boys, a large fire was kindled with driftwood on top of it. In another place, entirely separate and unconnected with the stone, a rude fireplace was constructed by digging a hole in the sand. Large pieces of flat stone were placed on three sides of the hole, while the side toward the wind was left open. He then placed six iron bars side by side on the top of the stone, with a space be-

tween them larger than the thickness of the bars. A fire built inside of this stove or fireplace drew admirably, and in a short time a bed of glowing embers was obtained, both on top of the separate stone as well as in the fireplace. As will be seen, the bars that were placed on the crude stove formed a species of gridiron on which a number of white and sweet potatoes were nicely baked. It was afterwards used for frying a lot of the weakfish, which some of the boys prepared for that purpose. While these cooking operations were going on, Mr. Bellground had the glowing embers raked off the large projecting stone and piled together, so as to keep their heat. He then piled the wet seaweed on the hot stone, covering it to a depth of nearly an inch. On this the clams were placed, covered with another layer of seaweed and the glowing embers were shoveled on top the pile. In this way, a lot of steam was soon formed in which the clams were most deliciously cooked.

At this stage in the preparations for the clam-bake, the "fixings" that Mr. Bellground had referred to arrived in a small wagon from the hotel. The boys were delighted to see them taken out. Among other things, a basket filled with nice buttered rolls, a lot of cakes, and two freezers of ice cream especially pleased them.

Yes, Mr. Bellground did understand boys! He was more than repaid for the trouble he had taken in the preparation for their novel meal. There was just enough of the wild, open air and somewhat savage life, to appeal to their minds, so that even if the clams had not been well cooked, or the potatoes been nicely baked, and the fish deliciously fried, which was far from being the case, they would have enjoyed their meal far more than they would a meal at the hotel.

"Well," said Bert to Fred, "we have had such a splendid time in our camp, that, before to-day, I thought it would be impossible to equal it, but this certainly goes far ahead of anything we have yet had."

"Right you are, Bert," said Fred. "Isn't Mr. Bellground a fine man?"

"I believe you, my boy," was the reply.

After eating, the boys had a game of ball on the beach. Here they found that Mr. Bellground was an expert in baseball, especially at the bat. He appeared to be able to put a ball wherever he wanted to. He also showed the boys some peculiar methods of delivery in pitching. He acknowledged, however, that Fred's "spit" ball was novel to him, and got Fred to explain how it was done.

"This kind of a ball," he explained to the boys, "came after my day. We never heard of such a thing when I was a boy. But it's great, boys, it is certainly great!'

On their return to the yacht, they had a pleasant sail up Toms River as far as the village of the same name, and returned to Island Heights, from which point they walked over to camp, after warmly thanking Mr. Bellground for the magnificent day he had given them.

CHAPTER XII

WHY THE SEA IS SALT

IT had grown into a custom while sitting around the camp fire at night, to call on the different members of the party for stories or songs. That night, after their pleasant time on the yacht and on the seashore, the boys called on Bert for a story.

"I will tell you a true fairy story," said Bert, "called 'The Wishing Machine, or Why the Sea is Salt.' "

"All right, Captain," said the boys, "sail in. It will come in very handy after our trip to the ocean."

"Once upon a time," began Bert, "there was a king who had two sons. The elder son was a disagreeable prince, selfish, greedy, ignorant,

lazy and, therefore, greatly disliked by his people."

"He is not in this camp, bedad," said Patsy, in a low tone.

"The younger prince, on the contrary, was a splendid fellow, with agreeable manners, liberal to a fault, well educated, industrious, and greatly loved by his people."

"Here's to ye, Captain Bert!" added Patsy.

"One day a powerful fairy, who lived in the kingdom, made the young prince a present of what she called a wishing machine. Now this machine possessed the very wonderful power of producing for any one who had it in his possession anything he wished for. It was only necessary to place the machine in the proper position, call on the machine to grind out the particular thing wished for, when it would instantly come out of an opening in the machine. The size of the article made no difference whatever. As soon as wished for, it would instantly appear at a small opening in the machine, and

on reaching the ground at once grew to its proper size. The young prince was naturally very proud of his present, and showed it to the king and queen in the presence of his elder brother.

" 'Now, mother,' he said, 'I want you to think of something you would like and I will produce it for you.'

"The queen did not believe that the machine would be able to produce what she called for, but, more to please her son than anything else, said:

" 'Well, suppose you give me a beautiful pearl necklace.'

"As soon as he heard his mother's request, the prince placed the machine in the proper position, and said:

" 'O Wishing Machine, grind out for me a pearl necklace more beautiful than any the world has ever seen!'

"Instantly there came from the machine a magnificent necklace of pearls, that the prince

caught in his hands and presented to his mother, pronouncing in a low tone the magic words for stopping this machine, a peculiarity of the machine being that unless it was stopped by the use of certain magic words it would continue to grind out whatever had been called for. The queen was much pleased with the necklace and in common with the courtiers marveled at the wonderful machine.

"The elder prince who was present at this time, seeing its power, at once made up his mind to try to get the machine for himself.

" 'Brother,' he said, 'what will you sell me your wishing machine for? I will give you my Arabian pony for it.'

" 'I certainly will not,' said the younger prince. 'Look at this!' and placing the wishing machine in the proper position, he called out:

" 'O Wishing Machine, grind me out an Arabian pony much more beautiful than that my brother owns.'

"Instantly there came out of the small opening of the machine a miniature pony, which, instantly, on reaching the ground, acquired its proper size, and trotted up to the young prince; and again in a low tone he pronounced the magic words for stopping the machine.

" 'See,' said the young prince to his brother, 'how foolish I would be if I gave you my wishing machine for anything that you have, since I could instantly obtain, by its proper use, a similar thing, only much better.'

"The elder prince, who saw it would be impossible to obtain the machine honestly, took the first opportunity and stole the machine from his brother, and ran away with it out of the kingdom, for, as he said to himself:

" 'With such a wonderful machine as this, I can easily set up another kingdom.'

"When the young prince discovered what had been done, he collected an army, and started out to overtake his brother and recover the stolen machine. Now, a thief is generally a coward,

and it was so in this case; for, as soon as the thieving prince heard that his brother was marching against him, he took to his heels and ran until he came to the seashore, just as a ship was about to sail. He made arrangements with the captain of the vessel, so that he and his followers entered the ship, and were at some little distance from the shore when the younger brother arrived. Seeing that he was too late, the young prince sorrowfully returned home without his machine.

"As the elder prince was sitting on the deck of the vessel about dinner time, his chef or cook came to him and said:

" 'Sire, thy servant is in great trouble!'

" 'What's the matter with you?' said the prince, crossly. 'Don't come here and bother me. I am hungry. When will dinner be ready?'

" 'O sire,' said the poor cook, 'that's just what troubles me. In the hurry of coming on board the vessel thy servant forgot to take any salt with him.'

" 'Oh, that's what troubles you, is it?' he said. 'It's a fortunate thing for you that you came to a man with brains. I will show you how to get over a little difficulty like that. What, ho, there! bring me my wishing machine. Captain, tell the bos'un to call all hands on deck. I am going to show them something worth looking at.'

"So the bos'un piped: 'All hands on deck at the request of His Majesty the Prince.'

"When the hands reached the deck, the prince, placing the wishing machine in the proper position, cried out:

" 'O Wishing Machine, grind me out salt.'

"As soon as the words reached the machine, there came from the opening in the machine, a great quantity of the finest and whitest of salt, that began to fall in front of the machine, where it was piled up, and then flowed over the decks of the vessel. It ran into the hold, thus filling the inside of the ship, and commenced running out of the scuppers and over the sides

of the vessel. In a short time so much had accumulated that the ship began to sink.

"The captain, becoming alarmed, cried out:

" 'O sire, stop the machine, or we shall all be drowned!'

"But the foolish prince who had only learned how to start the machine, was unable to stop it. He tried all the ways he knew, but unsuccessfully. The quantity of salt that the machine produced grew greater and greater, until at last the vessel sank, and all on board perished."

Then, stopping for a moment, Bert said:

"And that machine is still grinding out salt in McGinty's Land at the bottom of the sea, and that is the reason why the sea is salt; and this, I assure you, is a true story!"

There was a roar of laughter on the part of the boys when Bert assured them that the story was true.

"And you say, Captain Bert," exclaimed one of the boys, "that this story is true? Why, what do you take us for?"

"Sensible fellows," said Bert, "and I think I can make it clear to you."

"Bedad, then, Captain Bert," said Patsy, "you nade not do that, for it's Patsy O'Connor who remembers the great walk we took on one Saturday with Mr. Johnson, when there was a flood in the Schuylkill River, and we were obsarving the way the river was carrying the mountains to the say. I remember well that Mr. Johnson told us how, besides the mud that we could see in the river, there was a lot of salt and other substances dissolved in it, and that it was when this water reached the ocean the ocean was made salt, for the sun only dries up the fresh water and all the salt is left behind."

"That's right, Patsy," said Bert, nodding to him. "You understand, boys, that all river water contains a small quantity of salt, that it gets from solid substances dissolved out of the soil. Now, since the rivers are constantly draining into the ocean, the quantity of salt in the ocean must all the time be increasing, for

while it is salt water that runs into the ocean, it is only fresh water that is evaporated by the heat of the sun. The grinding out of salt by the wishing machine is like the water of the rivers that are constantly pouring into the ocean their dissolved salt, so you see that, in this sense, the story is true."

CHAPTER XIII

BERT SAVES FRED'S LIFE

CONCLUSION.

IT must not be supposed that Bert and Fred lost their interest in geology while in camp. On the contrary, they studied with great interest the peculiarities of the sand bars and mud flats, which were constantly forming on the banks of rivers and on the sea coast, wherever any obstruction impeded the free flow of the water. Nor were they the only boys who gave some time to such studies. Patsy, who had become greatly interested in the study of geology, was too bright a boy to neglect the opportunity of studying such things directly from nature.

One day, while Patsy and Bert were walking along the seashore at Seaside Park, near the mouth of Toms River, Patsy remarked:

"Faith, Captain Bert, I have been thinking to meself that whin I rayched the say, I should look for tokens of the broken up rocks that all rivers are carrying down to the say. Now, here is a river," he said, pointing to Toms River, "and there beyant us is the ocean. I intend to kape a lookout."

"That's right, Patsy," said Bert, "you may be a little disappointed, however, for Toms River is only a very short stream; it is, indeed, rather an arm of the sea. Still, we can find plenty to study in the formation of mud flats and sandbars and especially the deposit of Æolian rocks. Do you remember what kind of rocks these are?"

"Sure I do, Mr. Bert. I remember your spaking about them to Mr. Johnson on the first day he taught us. They are rocks that have been blown up in piles or layers by the winds."

As the boys were walking along the beach, the surf was unusually high. They could see, wherever stones or other obstructions projected

above the general level surface, the sand heaped up in places where the velocity of the water was checked, and gullied out where the velocity was increased.

"Do you moind thot," said Patsy, excitedly, to Bert, as the receding water, checked in its downward rush by one of these stones which projected above the surface of the beach, was dropping its load of sand. "Do you moind how the sand is being piled up forninst that rock that kapes the water from running off so fast."

"That's right, Patsy," said Bert, "that is the way sand bars and mud flats are formed. Wherever anything checks the velocity of the water, the sand and mud are dropped, and thus piled up. I remember reading that opposite our city of Philadelphia, about midway in the Delaware River between Chestnut and Market Streets, there was formerly an island called Smith's Island, that was formed by the settling of mud due to the checking of the motion of the water, by an obstruction due to the sinking of

a schooner. This island finally extended a considerable distance on both sides of this point, and hindered navigation so much that it was necessary to remove it."

On their return to camp, Bert called Patsy's attention to a high bluff or hill of sand on the bank of the Toms River between the camp and Island Heights.

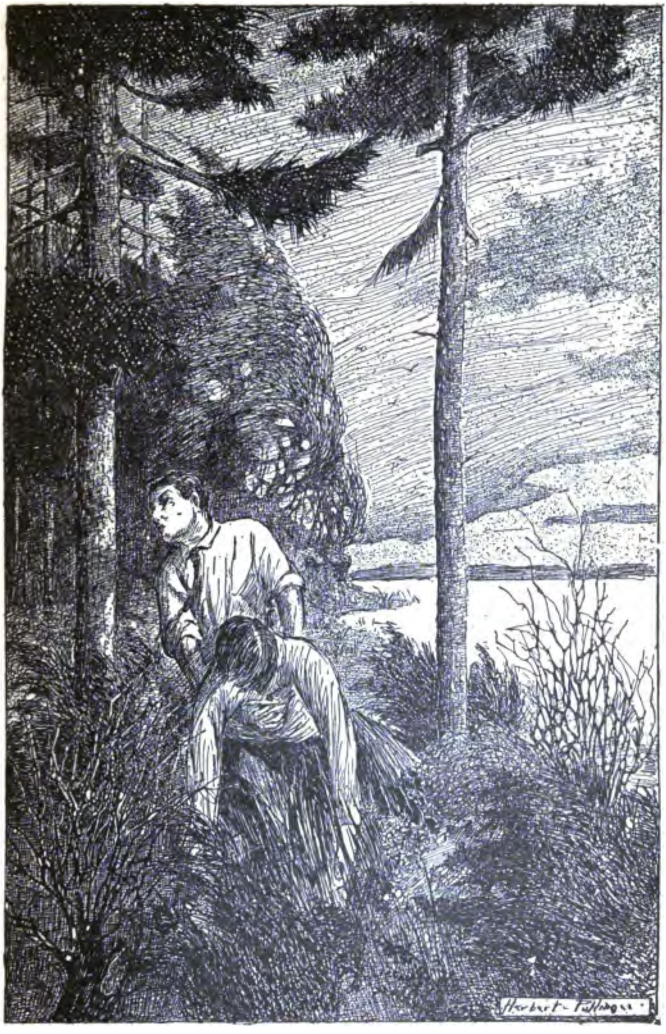
"Look at that, Patsy," said Bert. "I think that is a sand hill or dune that has been formed by the heaping up of the sand that has been blown over the coast."

One afternoon, a few days before the breaking up of the camp, there was a severe thunder storm. The day had been very hot and sultry, and the boys were lying around the camp either in their hammocks, or under the shade of trees. Fred had apparently fallen asleep under one of the trees. As the storm rapidly approached, Bert, who was near the tent, called the boys to aid him in seeing that the guy ropes were firmly fastened to the tent pins, as well as in partly

closing the tent, leaving the flap open so as to permit the boys who had now collected in the neighborhood of the tent to get inside when the rain began falling. Every boy had come up to the tent with the exception of Fred. Bert, remembering having seen Fred lying under a tree ran to the place, and was greatly alarmed to find that he was still lying there. He, of course, at once knew that something must be the matter with a boy who could remain apparently asleep despite the distant peals of thunder, the blowing of the wind, and other signs of the approaching storm. The rain had now commenced to fall in large drops, and peal after peal of thunder followed sharp lightning flashes. Running up to Fred, and kneeling over him, Bert felt that his temperature was very high, and he heard him muttering something that he could not understand, except every now and then he heard him say:

"Call Bert! Tell Bert to come here quickly!"

"Come here, boys," shouted Bert, "Fred is



"PULLED HIM FROM UNDER THE TREE TOWARD THE TENT"

sunstruck. Help me carry him to the tent as quickly as possible.''

The thunder storm was now directly overhead. The lightning flashes followed one another more rapidly, followed by loud crashes of thunder. It commenced to rain, and the wind was blowing furiously. So, without waiting for the boys, Bert seized Fred and pulled him from under the tree toward the tent. It was not a moment too soon, for he had only succeeded in dragging his friend some one hundred and fifty feet from the tree when a blinding lightning flash, followed by an apparently instantaneous crash of thunder, struck the tree and splintered it into pieces, leaving a large hole in the ground.

By this time, some of the boys had reached them, and seeing Fred unconscious, said:

''Has he been struck by lightning, Bert?''

''I think not,'' was the reply. ''When I found him, I believe he was suffering from sunstroke. We must see what we can do for him

as quickly as possible, for sunstroke is a very dangerous thing."

"What can we do to help you?" asked the boys, now thoroughly frightened at Fred's condition.

Bert knew from his general reading that there are two different forms of heat or sunstroke: a mild form, in which the patient manifests intense exhaustion, sometimes with a temperature that is slightly lower than the usual, and a more severe form, in which there is a marked rise of temperature. In this latter form, the patient suffers intense headache, dizziness and finally becomes unconscious. In this form the patient frequently becomes wildly delirious, struggling and fighting furiously.

In the first form, where the patient shows a marked decrease in temperature, the proper treatment consists of covering the body with blankets, and placing heated articles, such as hot stones or hot water bottles close to the body. In the second form, however, a very different

kind of treatment must be employed. Here efforts must instantly be taken to lower the temperature by the application of cold water, or ice, to the head, spine, or, indeed, to the surface of the body generally. In the first form stimulants are advisable. In the latter form, except during recovery, stimulants are to be carefully avoided.

There could be no doubt as to the form of sunstroke from which Fred was suffering, for his temperature was high and he was highly delirious. Bert, therefore, did not hesitate; he knew that whatever was done must be done promptly, so that when the boys, thoroughly frightened at Fred's condition, asked what they could do to help him, he replied:

"One of you run and try to get a doctor. I believe there is one at the camp further down the river. In the meantime, we must do what we can to lower his temperature."

Some of the boys helped Bert carry Fred to the tent, where they removed all his clothes. Bert

now commenced to pour ice water over his body, especially over his head, and down the spine. The effect was almost instantaneous. Fred, who had been struggling, so that he had to be held down by three or four boys, who had considerable difficulty in keeping him from injuring himself, at once quieted down, opened his eyes, recognized Bert and smiled at him.

"Where do you feel bad, Fred?" asked Bert, anxiously.

"My head, my head!" he said, almost instantly losing consciousness again and beginning to struggle.

"Bring me some more water, boys, and keep on bringing it as fast as you can!"

Another application of cold water resulted in Fred again regaining consciousness, this time remaining so for a longer time. He soon, however, again relapsed into unconsciousness, and began struggling. By the continued application of the cold water, Bert succeeded in so low-

ering his temperature that the immediate danger appeared to have passed. Fred fell into a quiet slumber, not, however, before Bert had dressed him with warm clothes, and wrapped him up in a blanket, opening the flap of the tent so that air could blow over him.

By this time the storm had passed, but it was fully three-quarters of an hour before the doctor arrived with the boy who had been sent for him. He listened to what Bert had to tell him, examined the patient, and said:

"This has been a bad case of sunstroke. What you have done has been quite right. I could not have done anything more had I been here. But let me say that if you had not promptly given your friend this treatment, he would probably either have been dead by this time, or would forever afterwards be a physical wreck; for, it is a dangerous thing to permit a high temperature, such as occurs in sunstroke, to continue even for a short time. I do not think any bad effects will follow this at-

tack," continued the doctor, who had been examining his body, "for the boy is in a splendid physical condition. Had it been otherwise, had he not taken good care of himself, even what you have done for him would most probably have been without avail."

The next day, the doctor called at the camp early, and was much pleased with Fred's condition.

"You had better stay around the camp at least until afternoon, when, if you feel like it, you can take a little walk," he said to Fred; "but I would not advise you to take much exercise until to-morrow."

The doctor recommended that Fred be kept for the next few days, on a diet of milk or such liquid food as soups or broths; or, now and then, a soft boiled egg, but that he might drink as much water as he wished. He appeared to be especially pleased to learn that there had been no recurrence of headache, saying that this fact would seem to prove that there had not been

any permanent injury to the nervous system. He said to Fred:

"I think you will feel no inconvenience in the future from this attack. I would advise you, however, not to expose yourself unnecessarily to the heat for the next few months. Don't forget that you owe your present condition to your friend, Bridges, for the excellent and prompt treatment he gave you, and also to the great care you appear to have taken of your general health."

When, next morning, Fred saw the place where the tree had been struck and the hole made in the ground, and had explained to him the particulars of his attack of sunstroke, he said:

"I have had a close call, Bert. From what the doctor tells me, even if I had not been killed outright by the lightning, which, judging from the size of the hole the bolt made, would, of course, have been the case, had you not removed me to a place of safety, I should most

probably have died from the heat stroke, but for the prompt treatment you gave me. You have, therefore, twice saved my life."

"That's all right, my dear fellow," was Bert's reply, "it only makes me even with you; for when you cleared me from the charge of theft at the Academy, you more than saved my life."

The day before the camp broke up, Bert and Fred planned a visit to some marl beds situated at a distance from the camp along the railroad. They made an early start. While there, Bert was fortunate in finding the fossil skeleton of a large reptilian animal, nearly all of the bones of which were complete. Boxing this specimen and sending it to the Academy, he was afterwards able, by the help of Mr. Johnson, to make what is called a "restoration," that is, he had the bones mounted, and where portions of the skeleton were missing, replaced them by artificial bones, shaped according to what they believed was their true shape. This specimen was

afterwards placed in the Academy collection, with the following label:

"Presented by Mr. Albert A. Bridges, a student of this Academy, who obtained this specimen from the marl beds at ——, New Jersey."

The camp broke up at the end of the ten days, as they had planned, and all the boys returned safely to their homes. With the exception of Fred's sunstroke, no accident of any kind had occurred.

They had a splendid time, and will never forget the pleasant days that were spent in Camp Mallory.

Fred made so complete a recovery from the attack of sunstroke that by the time of the Christmas holidays, his family physician had no hesitation in permitting him to take the proposed trip through Florida.

It will, of course, be impossible to describe in detail the very pleasant time the boys had on this famous trip. The examination had been

held and Bert had won the prize. To the great surprise of all, especially of Patsy, he had taken second prize, and Mr. Brown had generously offered to take Patsy along with the party. Bert and Patsy, who had never before gone very far outside of Philadelphia, experienced for the first time in their lives, the curious change in climate caused by a change of latitude. On the day the party left Philadelphia, a heavy snow was falling, covering everything with a thick blanket. It seemed strange to them, as they passed further and further south to find the weather getting warmer and warmer, and that, when at last they reached the southern part of Florida, the weather was like that of June in Philadelphia. The boys were then glad to put on their thin summer clothes, which, at the advice of Mr. Brown, they had brought with them.

Bert continued to study at the Academy, giving more and more of his time to the study of geology, after which he went to the university.

Before Bert completed his studies at the university, where he took a post-graduate course in geology, he joined his father in South Africa, where he aided him in making reports on the diamond mines of Kimberly, and on the gold deposits of Cape Colony. Subsequently, he went with his father to Australia to make a report on the gold deposits of that famous region. Of course, these visits interfered with his regular studies at the university, and necessitated a longer attendance, yet, on the whole, the loss was more than offset by the advantages gained, since this work not only gave Bert the opportunity of studying the field, but also of being with his father, who, as has already been mentioned, was a trained geologist, and we should add, a splendid teacher.

It is not surprising that with all this experience, Bert became one of the foremost geologists of the country. His reputation was so great that on several occasions he was employed by the United States Government to make

special reports on the geological features of different parts of the west. He was always able to obtain very remunerative work from large capitalists in America and other parts of the world for making expert examinations as to the value of properties that had been offered to them for sale. Since for all such work, Bert received excellent pay, he eventually became very wealthy and was able in after life, not only to take good care of his father, but to do what he always declared he would do for his mother, *i. e.*, obtain for her the best the world could afford. Not only while in Florida, but also in South Africa and Australia, Bert had many exciting and strange adventures, which may be afterwards told in subsequent volumes of "The Boy Geologist."

THE END